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PRECISE TRAVERSE AND TRIANGULATION IN INDIANA.

By CHARLES A. MOURHESS, *Mathematician*, and JASPER S. BILBY, *Signalman, United States Coast and Geodetic Survey.*

PART I.

INTRODUCTION.

This report contains geographic positions of all the points located by precise triangulation and precise traverse in the State of Indiana. The precise triangulation across the southern part of the State is a portion of the transcontinental triangulation along the thirty-ninth parallel. Extending south from it is a small arc which connects with a base line at Louisville, Ky. A full account of the scientific features of this triangulation has already been published; consequently all that is given here is for the practical use of the engineer or surveyor. Connecting with the thirty-ninth parallel triangulation and extending north from North Vernon to South Bend is a precise traverse. The field work on this traverse was done in 1920 under the direction of the authors. As this is the first time that the results of an arc of precise traverse have been published, both the field and office work are discussed at length in Part II. At South Bend the traverse joins the Lake Survey arc of precise triangulation, which runs along the northern boundary of the State, and by permission of the Chief of Engineers, U. S. Army, the results of this last-mentioned arc are included in this publication, which is thus a complete report on the precise horizontal control for the State of Indiana.

Four different grades of triangulation have recently been prescribed and defined by agreement of representatives of the various Federal map-making bureaus. The most accurate of these four grades is called precise triangulation. The ultimate criterion for classifying the different grades of triangulation is the actual error in the length of any line. This is indicated to a certain extent by the discrepancy between the measured length of a base line and its length as computed through the triangulation from the last preceding base. In precise triangulation this discrepancy must not exceed 1 part in 25 000.

To secure this accuracy certain standards are adopted for the field work, the most important one of which relates to the closing errors of the triangles or the discrepancy between the sum of the measured angles of a triangle and 180° plus the spherical excess of the triangle. In precise triangulation the average closing error of the triangles must not greatly exceed 1″ and the maximum error should not be more than 3″.

Precise traverse should be of the same relative degree of accuracy as that required for precise triangulation. The error in closure of position should not exceed 1 part in 25 000 of the distance run. Observed astronomic azimuths used for controlling the geodetic azimuths of the traverse should have an accuracy represented by a probable error of about 0.5″ and should occur at intervals of 10 or 15 main angle stations.

ARRANGEMENT OF SUBJECT MATTER.

Following a precedent recently established this publication has been arranged in two parts. Geographic positions, with descriptions and elevations of the stations, are arranged in tabulated form in Part I. Here the engineer and surveyor will find the data which will give him control points for his local surveys. Part II is devoted to a brief description of the methods employed in making the observations and to a discussion of the errors and methods of adjustment. Tabulations of different factors in the results are given as well as the condition equations used in making the adjustments. The triangulation has been fully treated in previous publications and so all discussion of it has been omitted here.

NORTH AMERICAN DATUM.

The North American datum serves as a basis for all the geodetic results contained in this publication. The explanation which follows has already been printed in about the same form in most of the previous reports on geodetic work.

Early in the year 1913 the Superintendent of the United States Coast and Geodetic Survey was notified by the director of the Comisión Geodésica Mexicana and by the chief astronomer of the Dominion of Canada Astronomical Observatory that the so-called United States standard datum had been adopted as the datum for the triangulation of those organizations. They also reported that the Clarke spheroid of 1866, now used in the United States, would be used by them.

Owing to the international character of the datum adopted by the three countries, the Superintendent of the United States Coast and Geodetic Survey changed its designation from the "United States standard datum" to the "North American datum."

EXPLANATION OF POSITIONS, LENGTHS, AND AZIMUTHS, AND OF THE NORTH AMERICAN DATUM.

All of the positions and azimuths have been computed upon the Clarke spheroid of 1866, as expressed in meters, which has been in use in the Coast and Geodetic Survey for many years.

After a spheroid has been adopted and all the angles and lengths in a triangulation have been fully fixed, it is still necessary, before the computation of latitudes, longitudes, and azimuths can be made, to adopt a standard latitude and longitude for a specified station and a standard azimuth of a line from that station. For convenience, the adopted standard position (latitude and longitude) of a given station, together with the adopted standard azimuth of a line from that station, is called the geodetic datum.

The triangulation in the United States was commenced at various points and existed at first as a number of detached portions in each of which the geodetic datum was necessarily dependent only upon the astronomic stations connected with that particular portion. As examples of such detached portions of triangulation there may be mentioned the early triangulation in New England and along the Atlantic coast, a detached portion of the transcontinental triangulation centering on St. Louis and another portion of the same triangulation in the Rocky Mountain region, and three separate portions of triangulation in California, in the latitude of San Francisco, in the vicinity of Santa Barbara Channel, and in the vicinity of San Diego. With the lapse of time these separate pieces expanded until they touched or overlapped.

The transcontinental triangulation, the office computation of which was completed in 1899, joined all of the detached portions mentioned and made them one continuous triangulation. As soon as this took place the logical necessity existed of discarding the old geodetic data used in these various pieces and substituting one for the whole country, or at least for as much of the country as is covered by continuous triangulation. To do this was a very heavy piece of work, and involved much preliminary study to determine the best datum to be adopted. On March 13, 1901, the Superintendent adopted what was known from that time until 1913 as the United States standard datum, but is now known as the North American datum (see p. 2), and it was decided to reduce the positions to that datum as rapidly as possible. The datum adopted was that formerly in use in New England, and therefore its adoption did not affect the positions which had been used for geographic purposes in New England and along the Atlantic coast to North Carolina, nor those in the States of New York, Pennsylvania, New Jersey, and Delaware. The adopted datum does not agree, however, with that used in The Transcontinental Triangulation and in The Eastern Oblique Arc of the United States, publications which deal primarily with the purely scientific problem of the determination of the figure of the earth and which were prepared for publication before the adoption of the new datum.

As the adoption of such a standard datum was a matter of considerable importance, it is in order here to explain the desirability of this step more fully.

The main objects to be attained by the geodetic operations of the Coast and Geodetic Survey are, first, the control of the charts published by the survey; second, the furnishing of geographic positions (latitudes and longitudes), accurately determined elevations, distances, and azimuths, to officers connected with the Coast and Geodetic Survey and to other organizations; third, the determination of the figure of the earth. For the first and second objects it is not necessary that the reference spheroid should be accurately that which most closely fits the geoid within the area covered, nor that the adopted geodetic datum should be absolutely the best that can be derived from the astronomic observations at hand. It is simply desirable that the reference spheriod and the geodetic datum adopted shall be, if possible, such a close approximation to the truth that any correction which may hereafter be derived from the observations which are now, or may become, available shall not greatly

exceed the probable errors of such corrections. It is, however, very desirable that one spheriod and one geodetic datum be used for the whole country. In fact, this is absolutely necessary if a geodetic survey is to perform fully the function of accurately coordinating all surveys within the area which it covers. This is the most important function of a geodetic survey. To perform this function, it is also highly desirable that when a certain spheriod and geodetic datum have been adopted for a country they be rigidly adhered to, without change, for all time, unless shown to be largely in error.

In striving to attain the third object, the determination of the figure of the earth, the conditions are decidedly different. This problem concerns itself primarily with astronomic observations of latitude, longitude, and azimuth, and with the geodetic positions of the points at which the astronomic observations were made, but is not concerned with the geodetic positions of other points fixed by the triangulations. The geodetic positions (latitude and longitudes) of comparatively few points are therefore concerned in this problem. However, in marked contrast to the statements made in preceding paragraphs, it is desirable in dealing with this problem that, with each new important accession of data, a new spheroid fitting the geoid with the greatest possible accuracy, and new values of the geodetic latitudes, longitudes, and azimuths of the highest degree of accuracy, should be derived.

The North American datum was adopted with reference to positions furnished for geographic purposes, but has no reference to the problem of the determination of the figure of the earth. It was adopted with reference to the engineer's problem of furnishing standard positions and does not affect the scientist's problem of the determination of the figure of the earth.

The principles which guided in the selection of the datum to be adopted were: First, that the adopted datum should not differ widely from the ideal datum for which the sum of the station errors in latitude, longitude, and azimuth should each be zero; second, it was desirable that the adopted datum should produce minimum changes in the publications of the Survey, including its charts; and, third, it was desirable, other things being equal, to adopt that datum which allowed the maximum number of positions already in the office files to remain unchanged, and therefore necessitated a minimum amount of new computation. These considerations led to the adoption, as the standard, of that datum which had been in use for many years in the northeastern group of States and along the Atlantic coast as far south as North Carolina.

An examination of the station errors of the astronomic stations so far reduced, scattered widely over the United States from Maine to Louisiana and to California, indicated that this datum approaches closely the ideal with which the algebraic sum of the station errors of each class would be zero.

The North American datum, upon which the positions and azimuths given in this publication depend, may be defined in terms of the position of the station Meades Ranch, Kansas, as follows:

	°	′	″
ϕ=39	13	26.686
λ=98	32	30.506
α to Waldo=75	28	14.52

Points are then said to be upon the North American datum when they are connected with the station Meades Ranch by a continuous triangulation, through which the corresponding latitudes, longitudes, and azimuths have been computed on the Clarke spheroid of 1866, as expressed in meters, starting from the above data.

USE OF HORIZONTAL CONTROL DATA.

The plan or map for any extensive engineering project, whether or not map construction is the primary object, should have all of its parts properly correlated and should be on the same datum as adjacent surveys. Federal and State mapping organizations have long been aware of the necessity for having all surveys based upon a common datum, but local engineers and surveyors in this country have too often in the past been content, and in many cases compelled, to use a local datum for their surveys. The future economic disadvantage of such a system is now becoming recognized, with the result that city and county surveys are being more generally placed upon a permanent basis by connecting them to stations on the North American datum.

One other factor must be taken into consideration by the engineer of to-day. As the States develop industrially they will undoubtedly follow the lead of one of the Eastern States, Massachusetts, which with splendid foresight has extended its triangulation control over the entire State for the purpose of defining property boundaries in terms of latitude and longitude. The advantage of such a system is well stated in the following extracts from the Report on the Maryland Oyster Survey:

> The difficulties of accurately locating and permanently defining the boundaries of a farmer's plantation on land, even with the aid of monuments, public roads, streams of water, and other points of reference are often great, judging from the disputes frequently arising in connection with boundaries. * * *
>
> There is only one point on the earth's surface at the intersection of any one parallel of latitude and any one meridian of longitude, and therefore there can be no dispute as to the meaning of such a geographic definition of the location of a point, even though all the original triangulation station marks used in its determination, together with the chart on which its position was originally plotted, have been totally destroyed.
>
> In the case of the destruction of an original triangulation station mark, or any other point defined by a geographic position, a competent geodetic engineer can reestablish its exact location by means of a new system of triangulation connecting with other distant triangulation marks which have not been destroyed.

In a section of the country covered by adequate geodetic control, the data are available to the engineer for any of the following operations, in addition to its possible future use as a basis for cadastral surveys:

(1) **Extensive mapping.**—The topographer needs as initial data for beginning a topographic survey the distance and direction between two points and the geographic position of one of them, in latitude and longitude, on the North American datum. His local triangulation or traverse, based on this control, will prevent the accumulation of excessive errors as he carries on his mapping operations. In the event that the available precise triangulation in that region has lines of too great length to join to conveniently, he can measure a base and azimuth at some place visible from a precise or a primary triangulation station and connect his base to the station by triangulation, thus obtaining proper geographic positions for his local surveys.

Instructions for secondary (formerly called tertiary) triangulation, suitable for the control of local surveys, may be found in U. S. Coast and Geodetic Survey Special Publication No. 26, which can be had at a nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C.

(2) **Boundary lines.**—If it is desired to locate or to delimit accurately and permanently the boundaries of political subdivisions, such as States, counties, or cities, the methods indicated in the preceding paragraph may be followed. Whenever possible, a line of the adjusted triangulation or traverse should be used as a basis for local surveys rather than a point, since a line gives the three essentials of position, length, and direction.

(3) **Local intensive surveys.**—The necessity for such surveys arises most frequently in connection with extensive improvements over a considerable area, or as a basis for city planning, where the needs of a city are being anticipated for a number of years. Here the requirements are somewhat different from those in the two preceding operations, for it is often necessary to extend precise or primary control in considerable detail over the entire area affected, secondary triangulation or traverse then being used to furnish additional points for the survey. In such a control survey the triangulation should invariably be started from a line of adjusted triangulation or traverse on the North American datum.

In local surveys where the area is of limited extent it is usually desirable to use a system of plane coordinates, the origin being connected to some point of the precise or primary triangulation scheme. Tables for computing plane coordinates from geographic positions are found in U. S. Coast and Geodetic Survey Special Publication No. 71.

The U. S. Coast and Geodetic Survey will be glad to give advice on any problem arising out of the use of its control points or on any proposed extension of triangulation or traverse from them.

EXPLANATION OF TABLES.

ARRANGEMENT OF TABULATED DATA.

In the tables of positions the latitude and longitude of each point are given on the North American datum (see p. 2); also the length and azimuth of each line observed over, whether in one way or both ways, to other points of the triangulation. NO LENGTHS OR AZIMUTHS ARE REPEATED, AND FOR A GIVEN LINE THE LENGTH AND AZIMUTH WILL BE FOUND OPPOSITE THE POSITION OF ONE OR THE OTHER OF THE TWO STATIONS INVOLVED.

The distances between stations are given in both meters and feet. To facilitate further the use of the tables, a column is given of the logarithms of the lengths in meters. It must be remembered that it is the logarithm of the length in meters which is derived first in the computation, the lengths in meters given in this table being derived from the corresponding logarithm and the lengths in feet in turn derived from the lengths in meters by the aid of the conversion tables on pages 59–66. Where further work of considerable extent is contemplated, an accumulation of error in the last two operations can be avoided by using the logarithm.

EXPLANATION OF LENGTHS.

The lengths as given in the tables are all reduced to sea level. If the actual length of a line simply reduced to the horizontal is desired—that is, its length in its actual elevation on the surface of the earth—it may be obtained by adding to the sea level length as given in meters a correction = (length of line as given in meters) times

$$\left[\frac{\text{mean elevation of the two ends of the line in meters}}{6370000}\right].$$

The maximum value of this correction does not exceed $\frac{1}{20000}$ of the length of any line of the triangulation here published. The error introduced by the use of the above approximate formula does not exceed $\frac{1}{500000}$ of the length of any line of the triangulation and traverse given in this publication.

AZIMUTH AND BACK AZIMUTH.

Because of the convergence of the meridians the azimuth and back azimuth of a line do not differ by exactly 180°, the amount of the divergence varying with the latitude and the difference of longitude of the two points. To illustrate from the tables, page 10, the azimuth from Tripp to Stout is 340° 41′ 43″.98, while the back azimuth, or the azimuth from Stout to Tripp, is 160° 44′ 11″.91.

The azimuths of the triangulation lines offer a very convenient and accurate means of testing the error of the magnetic needle on a surveyor's transit, and even the azimuth over such short distances as those between a station mark and its reference mark may be used for this purpose with fair accuracy, provided the distance is greater than 100 feet.

ACCURACY OF DATA INDICATED IN TABLES.

The rule followed in this office is to give latitudes and longitudes to thousandths of seconds for all points, the positions of which are fixed by fully adjusted triangulation or traverse. Points, the positions of which are given to hundredths of seconds only, are marked by footnotes as being without check (observed from only two stations) or checked by vertical angles only.

In the columns giving azimuths, distances, and logarithms of distances, the accuracy is indicated to a certain extent by the number of decimal places given, it being understood that in each case two doubtful figures are given. In some cases there is very little doubt of the correctness of the second figure from the right, while in a few cases some doubt may be cast on the third figure from the right.

HOW TO FIND THE DATA DESIRED.

Following the index at the back of this publication are 11 maps. The first is an index map showing all areas in the United States covered by published triangulation and traverse rigidly computed on the North American datum. Following this is an index map showing the boundaries of the areas represented on figures 16 to 24. The rest

are detailed maps showing the scheme of triangulation or traverse plotted by latitudes and longitudes. The traverse sketches are somewhat distorted in order to show the stations on the proper side of the track.

Having found the names of the points desired, the tables may be conveniently consulted by using the index at the end of this publication. In the appropriately headed columns opposite the name of each station are given the pages on which may be found its geographic position, description, and elevation above sea level, and the number of the detailed sketch showing the scheme of observed lines from that station.

RELATED PUBLICATIONS.

Engineers and others using the data given in this report for the control of maps and surveys will find it of help to have Special Publications Nos. 5, 8, and 71 of the U. S. Coast and Geodetic Survey. They may be obtained at a nominal cost from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Special Publication No. 5 is entitled "Tables for a polyconic projection of maps based on Clarke's reference spheroid of 1866." This publication contains the necessary explanation of the method employed in constructing a polyconic projection, and also gives the values in meters of the degrees, minutes, and seconds of latitude and longitude for all latitudes.

Special Publication No. 8 is entitled "Formulæ and tables for the computation of geodetic positions." As the title of this publication implies, the data contained in it will enable one to compute the spherical coordinates for triangulation where the distances and angles are known.

Special Publication No. 71 is entitled "Relation between plane rectangular coordinates and geographic positions." This book contains tables which will facilitate the use by engineers of plane coordinates for local surveys.

The principal lists of geographic positions published on the North American datum throughout the United States, together with descriptions of stations, are contained in the following publications of the U. S. Coast and Geodetic Survey and of other organizations:

Appendix 8 of the Report for 1888, positions in Connecticut.
Appendix 8 of the Report for 1893, positions in Pennsylvania, Delaware, and Maryland.
Appendix 6 of the Report for 1901, positions and descriptions in Kansas and Nebraska.
Appendix 4 of the Report for 1903, positions and descriptions in Kansas, Oklahoma, and Texas.
Appendix 9 of the Report for 1904, positions and descriptions in California.
Appendix 5 of the Report for 1905, positions and descriptions in Texas.
Appendix 3 of the Report for 1907, positions and descriptions in California.
Appendix 5 of the Report for 1910, positions and descriptions in California.
Appendix 4 of the Report for 1911, positions and descriptions in Nebraska, Minnesota, North Dakota, and South Dakota.
Appendix 5 of the Report for 1911, positions and descriptions in Texas.
Appendix 6 of the Report for 1911, positions and descriptions in Florida.
Special Publication No. 11, positions and descriptions in Texas, New Mexico, Arizona, and California.
Special Publication No. 13, positions and descriptions in California, Oregon, and Washington.
Special Publication No. 16, positions and descriptions in Florida.

Special Publication No. 17, positions and descriptions in Texas.
Special Publication No. 19, positions and descriptions in Colorado, Utah, Nevada, Wyoming, Montana, South Dakota, and North Dakota.
Special Publication No. 24, positions and descriptions in Alabama and Mississippi.
Special Publication No. 30, positions and descriptions in West Virginia, Ohio, Kentucky, Indiana, Illinois, and Missouri.
Special Publication No. 31, positions and descriptions in Oregon, Washington, and California.
Special Publication No. 43, positions in Georgia.
Special Publication No. 45, descriptions in Georgia.
Special Publication No. 46, positions and descriptions in Maine.
Special Publication No. 54, positions and descriptions in Texas.
Special Publication No. 62, positions and descriptions in Rhode Island.
Special Publication No. 70, positions and descriptions in Kansas.
Special Publication No. 74, positions and descriptions in Idaho, Oregon, and Washington.
Special Publication No. 76, positions and descriptions in Massachusetts.
Special Publication No. 78, positions and descriptions in Texas.
Special Publication No. 79, positions and descriptions in Indiana.
Report on triangulation of Greater New York.
Report on a plan of sewerage for the city of Cincinnati.
Appendix EEE, pages 2905–3031, Annual Report of the Chief of Engineers, U. S. Army, 1902, positions of points on and near the Great Lakes.
Professional Paper No. 24, Corps of Engineers, U. S. Army, descriptions of points on and near the Great Lakes.
Publications of the Massachusetts Commission on Waterways and Public Lands.
Various bulletins of the U. S. Geological Survey.

GEOGRAPHIC POSITIONS.

Precise triangulation along the thirty-ninth parallel.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points.	° ′ ″	° ′ ″	° ′ ″				
Dry Ridge, 1889..	38 40 41.112 84 34 40.043						
Tanner, 1889.....	39 00 03.064 84 39 06.362	349 48 49.21	169 51 36.23	Dry Ridge....	4.5611169	36401.30	119426.6
Stow, 1890.....	38 51 07.065 84 59 50.905	241 01 19.70 297 45 15.25	61 14 21.67 118 01 01.25	Tanner..... Dry Ridge....	4.5344508 4.6156194	34233.46 41268.57	112314.3 135395.3
Reizin, 1889.....	39 02 53.857 85 08 24.085	276 56 47.50 330 24 08.94	97 15 14.26 150 29 31.55	Tanner..... Stow.....	4.6295020 4.3988894	42609.07 25054.71	139793.3 82200.3
Culbertson, 1890..	38 49 56.092 85 11 35.465	190 51 41.94 262 35 57.60 287 32 49.66	10 53 42.22 82 43 19.48 107 55 56.50	Reizin..... Stow..... Dry Ridge....	4.3877916 4.2338121 4.7494627	24422.58 17132.16 56164.60	80126.4 56207.8 184266.7
Correct, 1890.....	39 00 56.697 85 16 59.801	253 42 58.06 338 59 16.56	73 48 22.83 159 02 40.34	Reizin..... Culbertson....	4.1112545 4.3388093	12919.76 21817.72	42387.6 71580.3
Glasgow, 1890.....	39 06 18.567 85 17 49.592	294 51 37.97 353 07 06.37	114 57 34.44 173 07 37.75	Reizin..... Correct.....	4.1757338 3.9998939	14987.66 9997.56	49172.0 32800.3
Green, 1890.....	39 06 09.779 85 30 10.134	269 03 45.17 296 51 53.32	89 11 32.25 117 00 11.33	Glasgow..... Correct.....	4.2503224 4.3286711	17796.00 21314.30	58385.7 69928.7
Holton north base, 1890.	39 04 48.842 85 22 19.580	102 29 14.67 246 52 50.83 312 55 24.70	282 24 17.96 66 55 41.08 132 58 46.15	Green..... Glasgow..... Correct.....	4.0637368 3.8484174 4.0214449	11580.75 7053.71 10506.18	37994.5 23142.0 34469.0
Holton south base, 1890.	39 01 50.926 85 22 03.204	124 19 56.39 175 53 47.07 216 25 54.54 282 52 41.90	304 14 49.52 355 53 36.75 36 28 34.38 102 55 52.93	Green..... Holton north base. Glasgow..... Correct.....	4.1513323 3.7404077 4.0111958 3.8743460	14168.78 5500.570 10261.14 7487.66	46485.4 18046.45 33665.1 24565.8
Mud Lick, 1890...	38 50 52.126 85 22 47.639	204 10 08.48 276 01 31.05	24 13 47.06 96 08 32.60	Correct..... Culbertson....	4.3104605 4.2122682	20439.04 16303.03	67057.1 53487.5
Stout, 1890.....	38 51 12.501 85 34 42.121	193 17 18.47 234 45 33.44 272 01 34.23	13 20 09.56 54 56 41.04 92 09 02.42	Green..... Correct..... Mud Lick.....	4.4538273 4.4954365 4.2365493	28433.30 31292.23 17240.48	93284.9 102664.6 56563.1
Tripp, 1890.....	38 59 58.155 85 38 37.560	226 45 04.30 340 41 43.98	46 50 23.99 160 44 11.91	Green..... Stout.....	4.2237412 4.2348441	16739.45 17172.92	54919.3 56341.5
Miller, 1889.....	38 50 36.473 86 02 08.848	242 52 48.97 268 15 14.43	63 07 35.62 88 32 27.36	Tripp..... Stout.....	4.5815595 4.5990736	38155.71 39725.89	125182.5 130334.0
Weed Patch, 1889.	39 10 00.634 86 13 00.771	276 21 07.30 290 21 27.79 336 20 23.14	96 48 09.77 110 43 08.55 156 27 13.46	Green..... Tripp..... Miller.....	4.7934405 4.7239141 4.5930291	62149.90 52955.87 39176.81	203903.5 173739.4 128532.6
Fountain, 1887....	38 56 36.824 86 15 17.290	187 31 54.46 300 15 02.24	7 33 20.48 120 23 17.28	Weed Patch .. Miller.....	4.3980053 4.3426545	25003.76 22011.75	82033.2 72216.9
Rariden, 1887.....	38 45 27.798 86 30 47.909	227 19 34.73 256 55 39.08	47 29 18.50 77 13 36.28	Fountain..... Miller.....	4.4840548 4.6290060	30482.80 42560.43	100009.0 139633.7
Leonard, 1887.....	39 06 28.225 86 36 17.122	258 49 32.83 300 55 43.03 348 26 25.03	79 04 14.18 121 08 56.31 168 29 51.91	Weed Patch .. Fountain..... Rariden.....	4.5336416 4.5486257 4.5984396	34169.73 35369.24 39667.94	112105.2 116040.6 130143.9
Beard, 1887.....	38 58 03.862 86 36 43.065	182 17 42.01 236 59 44.67 274 50 32.87 339 48 06.76	2 17 58.35 57 14 41.06 95 04 01.26 159 51 49.61	Leonard..... Weed Patch .. Fountain..... Rariden.....	4.1921666 4.6097543 4.4924204 4.3950978	15565.63 40714.99 31075.66 24836.93	51068.2 133579.1 101954.1 81485.8
Calvary, 1886.....	39 04 42.133 86 48 52.913	259 43 22.62 304 54 35.17	79 51 19.21 125 02 14.71	Leonard..... Beard.....	4.2661235 4.3309457	18455.40 21426.23	60549.1 70295.9
Osborn, 1886.....	38 51 23.456 86 52 35.794	192 16 16.78 241 38 27.97 289 02 58.99	12 18 36.95 61 48 26.41 109 16 38.67	Calvary..... Beard..... Rariden.....	4.4015105 4.4160477 4.5238621	25206.38 26064.40 33408.89	82697.9 85513.0 109609.0

GEOGRAPHIC POSITIONS—Continued.

Precise triangulation along the thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Sisson, 1885.....	38 58 11.846	253 25 33.12	73 43 21.71	Calvary.....	4.6290193	42561.74	139638.0
	87 17 10.030	289 23 36.74	109 39 02.77	Osborn.....	4.5761682	37684.97	123638.1
Wright, 1886.....	39 07 13.640	277 57 37.40	98 12 01.11	Calvary.....	4.5216442	33238.72	109050.7
	87 11 42.410	25 16 32.45	205 13 06.07	Sisson.....	4.2665127	18471.95	60603.4
Summit, 1884.....	38 45 42.538	197 37 21.29	17 40 32.63	Sisson.....	4.3846606	24247.15	79550.9
	87 22 14.956	256 05 05.47	76 23 40.53	Osborn.....	4.6453835	44196.05	144999.9
Merom College, 1885.	39 03 02.714	256 16 54.24	76 30 53.16	Wright.....	4.5172386	32903.23	107950.0
	87 33 53.017	290 18 06.40	110 28 37.74	Sisson.....	4.4106903	25744.85	84464.6
		332 16 01.76	152 23 20.18	Summit.....	4.5589233	36217.90	118824.9
Honey Creek, 1884.	38 55 28.776	221 57 30.82	42 03 00.35	Merom College	4.2750229	18837.48	61802.6
	87 42 36.781	301 25 20.68	121 38 07.00	Summit.....	4.5386913	34569.36	113416.3
Belle Air, 1879....	39 10 36.159	297 52 55.69	118 04 26.90	Merom College	4.4743082	29806.31	97789.5
	87 52 08.658	333 46 40.11	153 52 40.41	Honey Creek..	4.4938454	31177.79	102289.1
Hunt City, 1879..	39 03 58.583	225 55 14.02	46 00 47.10	Belle Air.....	4.2464700	17638.84	57870.1
	88 00.56.552	300 36 51.41	120 48 23.45	Honey Creek .	4.4883121	30783.08	100994.2
Claremont, 1879...	38 45 28.551	176 57 28.28	356 56 40.75	Hunt City....	4.5350164	34278.07	112460.6
	87 59 40.884	233 03 48.88	53 14 31.16	Honey Creek..	4.4894513	30863.94	101259.4
		269 20 56.50	89 44 22.59	Summit.....	4.7342291	54228.69	177915.3
Supplementary points.							
Wolf Hill, 1885....	38 47 56.220	292 38 50.5	112 43 06.4	Summit.....	4.028958	10689.5	35070
	87 29 03.558	166 01 08.4	345 58 06.5	Merom College	4.459540	28809.8	94520
Vincennes courthouse, center cupola, 1885.	38 40 35.216	195 15 51.8	15 17 28.0	Wolf Hill.....	4.149121	14096.8	46249
	87 31 37.354	235 03 21.8	55 09 13.6	Summit.....	4.219191	16565.0	54347
Vincennes latitude and longitude, 1881.	38 40 35.70						
	87 31 35.05						

Precise triangulation, thirty-ninth parallel, to Louisville, Ky.

Principal points.							
Blocher, 1914.....	38 43 33.837	111 35 15.60	291 20 55.58	Miller.....	4.5515578	35608.84	116826.7
	85 39 15.877	205 00 56.02	25 03 47.52	Stout.....	4.1934153	15610.45	51215.3
Finley, 1914.....	38 38 07.321	149 58 00.14	329 52 13.43	Miller.....	4.4264487	26696.15	87585.6
	85 52 54.807	227 22 05.76	47 33 29.61	Stout.....	4.5540339	35812.44	117494.6
		242 58 10.12	63 06 41.93	Blocher.....	4.3465086	22207.96	72860.6
Summit, 1886.....	38 34 15.852	135 40 23.82	315 37 23.91	Finley.....	3.9991921	9981.41	32747.3
	86 48 06.444	216 39 57.45	36 45 28.81	Blocher.....	4.3316828	21462.62	70415.3
Marysville, 1914...	38 35 20.932	81 32 33.22	261 26 47.51	Summit.....	4.1325077	13567.75	44513.5
	85 38 52.075	104 11 50.22	284 03 04.32	Finley.....	4.3227337	21024.89	68979.2
		177 50 00.87	357 49 46.00	Blocher.....	4.1821210	15209.71	49900.5
O. & M., 1884.....	38 29 00.278	130 15 56.43	310 11 00.59	Summit.....	4.1780496	15067.79	49434.9
	85 40 11.497	189 18 01.27	9 18 50.75	Marysville....	4.0753229	11893.86	39021.8
Popp, 1914.....	38 25 14.301	184 03 19.35	4 03 49.79	Summit.....	4.2237646	16740.35	54922.3
	85 48 55.348	217 57 16.13	38 03 31.72	Marysville....	4.3754662	23739.21	77884.4
		241 12 29.15	61 17 54.91	O. & M.....	4.1610058	14487.91	47532.4
Lutz, 1884.....	38 24 34.310	95 32 28.19	275 26 59.94	Popp.....	4.1097669	12875.57	42242.6
	85 40 07.062	179 14 56.82	359 14 54.06	O. & M.....	3.9138971	8201.57	26908.0
Six Mile, 1884.....	38 22 37.953	178 06 54.44	358 06 50.38	Popp.....	3.6833556	4823.43	15824.9
	85 48 48.808	226 44 29.60	46 49 51.14	O. & M.....	4.2359474	17216.60	56484.8
		254 08 04.39	74 13 28.42	Lutz.....	4.1192566	13160.02	43175.8

GEOGRAPHIC POSITIONS—Continued.

Precise triangulation, thirty-ninth parallel, to Louisville, Ky.—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Sims, 1884	38 20 35.973	105 55 13.62	285 49 35.53	Six Mile	4.1383314	13750.91	45114.4
	85 39 44.027	175 39 03.70	355 38 49.40	Lutz	3.8674702	7370.05	24179.9
Bangs, 1879	38 19 36.717	212 47 08.86	32 48 40.88	Six Mile	3.8226878	6647.95	21810.8
	85 51 17.115	263 44 44.40	83 51 54.29	Sims	4.2287069	16931.95	55550.9
Blind Asylum, 1879.	38 15 24.227	122 11 06.35	302 05 50.40	Bangs	4.1653456	14633.41	48009.8
	85 42 47.242	146 44 02.92	326 40 18.74	Six Mile	4.2041149	15999.81	52492.7
		204 50 08.28	24 52 01.83	Sims	4.0250216	10593.06	34754.1
Williams, 1879	38 10 24.695	196 44 43.75	16 46 54.29	Bangs	4.2498327	17775.95	58319.9
	85 54 47.969	242 09 37.93	62 17 03.78	Blind Asylum	4.2970333	19816.79	65015.6
Cox, 1879	38 09 24.220	98 35 57.29	278 30 42.69	Williams	4.0980701	12533.44	41120.1
	85 46 18.845	159 00 53.52	338 57 48.90	Bangs	4.3059988	20230.13	66371.7
		204 51 50.71	24 54 01.59	Blind Asylum	4.0876324	12235.80	40143.6
Louisville north base, 1879.	38 13 29.002	326 05 53.97	146 08 02.74	Cox	3.9586240	9091.26	29826.9
	85 49 47.122	52 12 14.05	232 09 08.01	Williams	3.9669467	9267.16	30404.0
Louisville south base, 1879.	38 09 03.583	109 32 49.77	289 29 50.75	Williams	3.8741201	7483.76	24553.0
	85 49 58.232	181 53 28.93	1 53 35.80	Louisville north base.	3.9131808	8188.057	26863.65
		263 11 16.62	83 13 32.15	Cox	3.7307253	5379.29	17648.6
Riley, 1879	38 05 30.379	117 28 28.99	297 21 05.38	Williams	4.2946821	19709.80	64664.6
	85 42 49.556	154 43 10.61	334 37 56.67	Bangs	4.4604346	28869.19	94715.0
		180 10 33.87	0 10 35.30	Blind Asylum	4.2626876	18309.97	60072.0
Potts, 1880	38 05 23.771	191 48 02.82	11 48 52.00	Williams	3.9767523	9478.78	31098.3
	85 56 07.608	269 19 52.86	89 28 05.19	Riley	4.2888818	19448.31	63806.7
Supplementary points.							
Haystack, 1884	38 25 14.272	184 03 53.56	4 04 24.07	Summit	4.2237934	16741.46	54925.9
	85 48 55.466	241 12 37.27	61 18 03.10	O. & M	4.1610939	14490.85	47542.1
Bartle, 1886	38 30 21.028	217 06 17.15	37 08 38.15	Summit	3.9581434	9081.20	29793.9
	85 51 52.750	278 16 29.06	98 23 45.55	O. & M	4.2349073	17175.42	56349.7
		335 32 48.69	155 34 38.96	Haystack	4.0165881	10389.34	34085.7
New Albany Second Presbyterian Church, 1880.[1]	38 17 03.78	146 53 56	326 52 37	Bangs	3.750498	5629.9	18471
	85 49 10.54	182 55 49	2 56 02	Six Mile	4.013563	10317.2	33849
New Albany waterworks tower, 1880.[1]	38 16 53.92	165 01 01	345 00 26	Bangs	3.715693	5196.3	17048
	85 50 21.81	192 00 48	12 01 46	Six Mile	4.035249	10845.5	35582
Jeffersonville, Government tower, 1880.[1]	38 17 00.20	115 50 53	295 46 39	Bangs	4.044663	11083.1	36362
	85 44 26.48	148 33 47	328 31 04	Six Mile	4.086668	12208.7	40055

Precise traverse—North Vernon to South Bend.

Principal points.							
Adams, 1920	39 00 23.790	3 40 10.5	183 40 09.2	Tripp	2.8988006	792.14	2598.9
	85 38 35.453						
North Vernon, 1920.	39 00 25.053	88 36 45.4	268 36 03.5	Adams	3.2046392	1601.91	5255.6
	85 37 28.896						
Allen, 1920	39 00 48.188	316 37 33.1	136 37 50.7	North Vernon	2.9918632	981.44	3219.9
	85 37 56.908						
Bartholomew, 1920.	39 02 00.724	317 46 07.4	137 47 00.5	Allen	3.4800912	3020.59	9910.1
	85 39 21.293						

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Benton, 1920	39 02 20.086 85 39 40.599	322 07 36.7	142 07 48.9	Bartholomew	2.8787383	756.38	2481.6
Blackfork, 1920	39 03 28.051 85 41 22.295	310 35 19.4	130 36 23.5	Benton	3.5079543	3220.73	10566.7
Boon, 1920	39 03 49.041 85 41 55.412	309 06 20.4	129 06 41.3	Blackfork	3.0112017	1026.13	3366.6
Brown, 1920	39 07 15.095 85 47 21.525	309 00 19.7	129 03 45.3	Boon	4.0038688	10089.48	33101.9
Corroll, 1920	39 09 49.753 85 51 27.905	308 50 57.0	128 53 32.5	Brown	3.8807971	7599.71	24933.4
Cass, 1920	39 10 19.662 85 52 14.851	309 17 30.9	129 18 00.5	Corroll	3.1632561	1456.32	4777.9
Columbus, 1920	39 12 16.805 85 55 21.573	308 51 24.6	128 53 22.6	Cass	3.7601196	5755.98	18884.4
Clay, 1920	39 12 31.588 85 55 22.328	357 43 23.9	177 43 24.4	Columbus	2.6592007	456.25	1496.9
Clark, 1920	39 13 20.918 85 55 59.306	329 44 53.9	149 45 17.3	Clay	3.2457576	1760.99	5777.5
Clinton, 1920	39 18 11.380 85 57 08.130	349 33 24.5	169 34 08.0	Clark	3.9594274	9108.09	29882.1
Edinburg, 1920	39 20 53.815 85 57 48.128	349 10 08.1	169 10 33.4	Clinton	3.7075777	5100.09	16732.5
Crawford, 1920	39 21 35.497 85 57 58.191	349 22 59.4	169 23 05.8	Edinburg	3.1165479	1307.82	4290.7
Daviess, 1920	39 23 01.995 85 58 40.049	339 24 33.2	159 24 59.7	Crawford	3.4547661	2849.48	9348.7
Dearborn, 1920	39 24 07.294 85 59 12.069	339 09 56.3	159 10 16.6	Daviess	3.3333661	2154.60	7068.9
Decature, 1920	39 26 34.574 86 00 38.995	335 23 41.4	155 24 36.6	Dearborn	3.6985620	4995.30	16388.7
Decalb, 1920	39 27 24.356 86 01 07.857	335 47 34.9	155 47 53.2	Decature	3.2261417	1683.22	5522.4
Delaware, 1920	39 27 38.169 86 01 20.998	323 35 22.6	143 35 31.0	Decalb	2.7237011	529.30	1736.5
Dubois, 1920	39 28 38.463 86 02 51.714	310 36 17.7	130 37 15.4	Delaware	3.4558394	2856.53	9371.8
Franklin, 1920	39 28 52.707 86 03 04.176	325 51 33.5	145 51 41.4	Dubois	2.7248679	530.72	1741.2
Elkhart, 1920	39 29 57.723 86 03 29.136	343 25 53.5	163 26 08.4	Franklin	3.3205416	2091.90	6863.2
Whiteland, 1920	39 32 31.835 86 04 29.396	343 08 45.3	163 09 23.6	Elkhart	3.6960026	4965.95	16292.5
Fayette, 1920	39 34 01.350 86 05 03.900	343 22 54.7	163 23 16.7	Whiteland	3.4595321	2880.93	9451.9
Floyd, 1920	39 36 19.270 86 05 58.022	343 06 15.9	163 06 50.4	Fayette	3.6478968	4445.26	14584.2
Greenwood, 1920	39 37 22.276 86 06 22.171	343 29 06.8	163 29 22.2	Floyd	3.3067935	2026.72	6649.3

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Fountain, 1920....	39 38 45.132 86 06 54.796	343 03 47.8	163 04 08.6	Greenwood....	3.4266936	2671.12	8763.5
Fulton, 1920.....	39 40 46.198 86 07 41.870	343 16 05.9	163 16 36.0	Fountain.....	3.5909225	3898.72	12791.1
Traction, 1920....	39 42 26.254 86 08 21.588	342 56 48.9	162 57 14.3	Fulton.....	3.5088884	3227.66	10589.4
Shelby, 1920.....	39 43 03.546 86 08 21.813	359 44 00.5	179 44 00.6	Traction.....	3.0607518	1150.14	3773.4
Troy, 1920.....	39 43 22.413 86 08 21.881	359 50 26.3	179 50 26.3	Shelby.....	2.7648368	581.88	1909.1
Kerk, 1920.....	39 43 23.393 86 07 08.131	89 01 14.0	269 00 26.9	Troy.....	3.2447087	1756.74	5763.6
Sherman, 1920....	39 43 24.013 86 06 05.781	89 16 05.1	269 15 25.3	Kerk.....	3.1717554	1485.10	4872.4
Elevator, 1920....	39 44 26.921 86 06 06.488	359 30 09.8	179 30 10.3	Sherman.....	3.2878491	1940.21	6365.5
Prospect, 1920....	39 45 08.973 86 06 06.761	359 42 45.9	179 42 46.1	Elevator.....	3.1129171	1296.93	4255.0
Michigan, 1920....	39 45 09.259 86 05 51.416	88 37 02.7	268 36 52.9	Prospect.....	2.5628006	365.43	1198.9
Emerson, 1920....	39 45 10.108 86 04 58.576	88 48 44.1	268 48 10.3	Michigan.....	3.0997492	1258.20	4127.9
Subway, 1920.....	39 45 34.302 86 04 58.396	0 19 45.5	180 19 45.4	Emerson.....	2.8728350	746.17	2448.1
Thoaman, 1920...	39 47 00.663 86 04 59.465	359 27 09.0	179 27 09.7	Subway.....	3.4254672	2663.59	8738.8
Pendleton, 1920...	39 48 48.685 86 05 00.426	359 36 24.7	179 36 25.3	Thoaman.....	3.5226571	3331.63	10930.5
Avenue, 1920.....	39 49 31.829 86 05 01.272	359 08 00.4	179 08 00.9	Pendleton.....	3.1241077	1330.78	4366.1
Brightwood, 1920.	39 49 30.928 86 06 27.611	269 13 00.3	89 13 55.6	Avenue.....	3.3124843	2053.45	6737.0
Keystone, 1920...	39 49 30.841 86 07 18.191	269 52 04.4	89 52 36.8	Brightwood...	3.0802203	1202.87	3946.4
Lake, 1920.....	39 50 19.168 86 07 18.665	359 33 59.9	179 34 00.2	Keystone.....	3.1733368	1490.52	4890.1
Erie, 1920.....	39 50 39.604 86 07 18.855	359 35 19.5	179 35 19.6	Lake.....	2.7995416	630.29	2067.9
Western, 1920.....	39 50 58.310 86 07 08.467	23 10 29.6	203 10 22.9	Erie.....	2.7976454	627.55	2058.9
Gibson, 1920.....	39 51 53.805 86 06 04.485	41 37 47.1	221 37 06.1	Western.....	3.3597703	2289.66	7512.0
Grant, 1920.....	39 52 23.391 86 05 19.309	49 38 35.7	229 38 06.7	Gibson.....	3.1489259	1409.05	4622.9
Green, 1920.....	39 53 31.316 86 03 36.633	49 21 28.3	229 20 22.5	Grant.....	3.5072830	3215.76	10550.4
Castleton, 1920....	39 55 46.141 86 02 05.350	27 32 46.0	207 31 47.5	Green.....	3.6711325	4689.56	15385.7
Fisher, 1920.....	39 57 42.835 86 00 46.758	27 24 33.2	207 23 42.8	Castleton.....	3.6078778	4053.94	13300.3

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Frazier, 1920	39 58 11.983 86 00 30.319	23 27 44.3	203 27 33.7	Fisher	2.9912220	979.99	3215.2
Hamilton, 1920	39 59 39.770 86 00 31.085	359 36 55.4	179 36 55.9	Frazier	3.4325851	2707.60	8883.2
Hancock, 1920	40 00 02.908 86 00 31.721	358 47 18.0	178 47 18.4	Hamilton	2.8535692	713.79	2341.8
Harrison, 1920	40 00 56.853 86 00 32.020	359 45 20.3	179 45 20.5	Hancock	3.2211022	1663.80	5458.7
Stake, 1920	40 01 07.175 86 00 36.272	342 25 33.7	162 25 36.4	Harrison	2.5236757	333.95	1095.6
Stub, 1920	40 01 20.988 86 00 47.621	327 43 02.2	147 43 09.5	Stake	2.7023594	503.92	1653.3
Sub, 1920	40 01 32.326 86 00 51.714	344 29 12.3 126 03 31.6	164 29 14.9 306 03 28.0	Stub Fill	2.559808 2.209106	362.9 161.8	1191 531
Fill, 1920	40 01 35.415 86 00 57.232	332 52 40.1	152 52 46.3	Stub	2.6989106	499.93	1640.2
Hendricks, 1920	40 03 11.308 86 01 16.763	351 06 01.1	171 06 13.7	Fill	3.4761978	2993.63	9821.6
Brays, 1920	40 04 21.879 86 01 16.498	0 09 55.1	180 09 54.9	Hendricks	3.3377813	2176.61	7141.1
Fox, 1920	40 05 04.207 86 01 15.471	1 04 05.2	181 04 04.5	Brays	3.1158546	1305.73	4283.9
Prairie, 1920	40 05 27.479 86 01 12.241	6 05 08.3	186 05 06.2	Fox	2.8584335	721.83	2368.2
Henry, 1920	40 07 30.871 86 00 53.833	6 32 12.5	186 32 00.6	Prairie	3.5832736	3830.66	12567.8
Cicero, 1920	40 08 02.372 86 00 49.459	6 05 03.8	186 05 01.0	Henry	2.9899268	977.07	3205.6
Tucker, 1920	40 08 17.307 86 00 52.083	352 19 06.9	172 19 08.6	Cicero	2.6672670	464.80	1524.9
Howard, 1920	40 08 39.414 86 01 07.500	331 50 26.0	151 50 35.9	Tucker	2.8883836	773.36	2537.3
Kinders, 1920	40 09 32.981 86 01 13.798	354 50 38.5	174 50 42.6	Howard	3.2198175	1658.89	5442.5
Arcada, 1920	40 11 15.036 86 01 24.606	355 21 16.1	175 21 23.1	Kinders	3.4994256	3158.10	10361.2
Cox, 1920	40 14 48.507 86 01 46.516	355 29 56.7	175 30 10.8	Arcada	3.8198434	6604.55	21668.4
Jay, 1920	40 16 14.729 86 01 55.762	355 18 07.8	175 18 13.8	Cox	3.4262475	2668.38	8754.5
Jasper, 1920	40 16 37.989 86 02 01.289	349 41 00.1	169 41 03.7	Jay	2.8628530	729.21	2392.4
Tipton, 1920	40 16 59.046 86 02 15.055	333 24 05.7	153 24 14.6	Jasper	2.8611495	726.36	2383.1
Ressler, 1920	40 18 13.700 86 02 52.064	339 12 32.3	159 12 56.2	Tipton	3.3914551	2462.95	8080.5
Jackson, 1920	40 19 49.124 86 03 40.120	338 54 48.6	158 55 19.7	Ressler	3.4989195	3154.42	10349.1

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
New Hope, 1920..	40 20 52.334 86 04 11.522	339 10 55.3	159 11 15.6	Jackson.....	3.3192714	2085.80	6843.2
Midway, 1920.....	40 21 56.040 86 04 43.255	339 08 10.5	159 08 31.0	New Hope....	3.3227982	2102.80	6898.9
Sharp, 1920.....	40 23 09.086 86 05 19.268	339 20 11.5	159 20 34.8	Midway.....	3.3816426	2407.92	7900.0
Jefferson, 1920....	40 24 23.543 86 05 56.316	339 10 03.7	159 10 27.7	Sharp.....	3.3904365	2457.18	8061.6
Duncan, 1920.....	40 25 51.542 86 06 30.078	343 39 11.5	163 39 33.4	Jefferson.....	3.4515722	2828.60	9280.2
Jennings, 1920....	40 27 30.484 86 07 08.390	343 30 57.0	163 31 21.8	Duncan.....	3.5027837	3182.61	10441.6
Main, 1920.....	40 28 35.528 86 07 52.515	332 36 21.4	152 36 50.0	Jennings.....	3.3540316	2259.60	7413.4
Buckeye, 1920....	40 28 49.160 86 07 56.517	347 21 44.7	167 21 47.3	Main.....	2.6343867	430.91	1413.7
Kokomo, 1920....	40 29 30.896 86 07 56.737	359 46 11.2	179 46 11.3	Buckeye.....	3.1096980	1287.35	4223.6
Penn, 1920.....	40 29 48.057 86 07 53.736	7 36 21.5	187 36 19.5	Kokomo.....	2.7275533	534.01	1752.0
Lacy, 1920.....	40 30 30.290 86 08 21.346	333 28 31.1	153 28 49.0	Penn.....	3.1631315	1455.90	4776.6
Cassedy, 1920.....	40 33 31.626 86 10 22.756	332 55 41.2	152 57 00.1	Lacy.....	3.7980265	6280.97	20606.8
Shope, 1920.....	40 38 08.066 86 13 27.057	333 02 35.4	153 04 35.3	Cassedy.....	3.9806829	9564.95	31381.0
Bennett, 1920.....	40 38 56.339 86 13 59.715	332 43 56.2	152 44 17.5	Shope.....	3.2240451	1675.12	5495.8
Laporte, 1920.....	40 41 18.018 86 15 34.061	333 06 11.5	153 07 13.0	Bennett.....	3.6901926	4899.96	16076.0
Anoka, 1920.....	40 43 06.130 86 16 46.415	333 00 07.0	153 00 54.2	Laporte.....	3.5731632	3742.51	12278.6
Junction, 1920....	40 43 45.642 86 17 26.452	322 21 58.9	142 22 25.0	Anoka.....	3.1872267	1538.96	5049.1
Laurra, 1920.....	40 43 51.938 86 17 54.275	286 33 49.1	106 34 07.3	Junction.....	2.8332653	681.19	2234.9
Frate, 1920.....	40 44 08.039 86 20 07.715	279 00 01.8	99 01 28.9	Laurra.....	3.5011098	3170.37	10401.5
Yarde, 1920.....	40 44 14.797 86 20 29.129	292 31 52.9	112 32 06.9	Frate.....	2.7355942	543.99	1784.7
Wabash, 1920.....	40 44 28.412 86 20 55.341	304 19 31.2	124 19 48.3	Yarde.....	2.8719999	744.73	2443.3
River, 1920.....	40 44 51.711 86 21 08.379	336 56 34.0	156 56 42.5	Wabash.....	2.8926901	781.07	2562.6
Lagrange, 1920....	40 45 00.657 86 21 27.436	301 40 59.9	121 41 12.3	River.....	2.7204759	525.38	1723.7
Mulborn, 1920....	40 45 07.304 86 21 48.322	292 42 19.7	112 42 33.3	Lagrange.....	2.7251978	531.13	1742.5
Logansport, 1920..	40 45 04.758 86 21 59.764	253 41 18.6	73 41 26.1	Mulborn.....	2.4466422	279.67	917.6

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Eel, 1920	40 45 21.004 86 22 04.464	347 35 27.8	167 35 30.9	Logansport	2.7102208	513.12	1683.5
Miami, 1920	40 45 28.739 86 22 10.951	327 28 19.6	147 28 23.8	Eel	2.4517844	283.00	928.5
Vandalia, 1920	40 45 33.772 86 22 13.486	339 02 35.0	159 02 36.7	Miami	2.2207790	166.26	545.5
Leonda, 1920	40 45 36.516 86 21 45.699	82 36 07.9	262 35 49.8	Vandalia	2.8177244	657.24	2156.3
Knox, 1920	40 45 45.129 86 21 30.508	53 17 39.1	233 17 29.2	Leonda	2.6478300	444.46	1458.2
Horney, 1920	40 45 53.513 86 21 26.341	20 42 15.7	200 42 13.0	Knox	2.4416520	276.47	907.1
Laurence, 1920	40 46 07.086 86 21 27.471	356 22 46.3	176 22 47.0	Horney	2.6227482	419.52	1376.4
Lawn, 1920	40 47 16.362 86 21 08.334	11 51 42.5	191 51 30.0	Laurence	3.3391600	2183.53	7163.8
Martha, 1920	40 47 26.442 86 21 10.412	351 05 32.2	171 05 33.6	Lawn	2.4979298	314.72	1032.5
Madison, 1920	40 47 43.685 86 21 20.748	335 30 20.4	155 30 27.2	Martha	2.7667754	584.49	1917.6
Marion, 1920	40 48 02.667 86 21 34.301	331 30 51.0	151 30 59.9	Madison	2.8235937	666.18	2185.6
Marchal, 1920	40 49 12.739 86 22 33.696	327 12 38.3	147 13 17.1	Marion	3.4100997	2570.99	8435.0
Martin, 1920	40 51 07.144 86 24 08.591	327 46 48.5	147 47 50.6	Marchal	3.6202400	4171.00	13684.4
Monroe, 1920	40 51 22.818 86 24 11.922	350 49 56.1	170 49 58.3	Martin	2.6899638	489.74	1606.8
Lucerne, 1920	40 52 34.144 86 24 12.378	359 43 18.4	179 43 18.7	Monroe	3.3424638	2200.21	7218.5
Boon, 1920	40 53 04.765 86 24 13.363	358 36 03.5	178 36 04.1	Lucerne	2.9753599	944.84	3099.9
Montgomery, 1920	40 54 25.986 86 24 13.738	359 47 57.4	179 47 57.7	Boon	3.3988873	2505.46	8220.0
Morgan, 1920	40 55 30.610 86 24 13.452	0 11 31 9	180 11 31.7	Montgomery	3.2996138	1993.49	6540.3
Grass, 1920	40 57 50.507 86 24 16.317	359 06 36.5	179 06 38.4	Morgan	3.6350821	4316.01	14160.1
Newton, 1920	40 59 49.216 86 24 17.289	359 38 39.2	179 38 39.8	Grass	3.5637152	3661.97	12014.3
Noble, 1920	41 00 40.188 86 24 32.263	347 27 03.8	167 27 13.6	Newton	3.2070514	1610.84	5284.9
Kewanna, 1920	41 01 19.767 86 24 33.030	359 09 30.8	179 09 31.3	Noble	3.0867385	1221.06	4006.1
Ohio, 1920	41 02 27.511 86 24 52.059	347 59 21.8	167 59 34.3	Kewanna	3.3297045	2136.51	7009.5
Orange, 1920	41 02 54.002 86 24 52.593	359 07 34.8	179 07 35.2	Ohio	2.9123736	817.29	2681.4
Owen, 1920	41 04 47.056 86 24 52.304	0 06 39.2	180 06 39.0	Orange	3.5425173	3487.52	11442.0

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Park, 1920	41 06 15.850 86 24 51.836	0 13 42.8	180 13 42.5	Owen	3.4376158	2739.15	8986.7
Perry, 1920	41 07 18.075 86 25 09.320	348 00 03.6	168 00 15.1	Park	3.2927927	1962.42	6438.4
Delong, 1920	41 08 16.988 86 24 53.293	11 37 30.4	191 37 19.9	Perry	3.2684407	1855.41	6087.3
Porter, 1920	41 10 30.903 86 24 53.635	359 53 21.6	179 53 21.8	Delong	3.6160674	4131.12	13553.5
Posey, 1920	41 11 36.857 86 24 57.016	357 46 53.0	177 46 55.2	Porter	3.3088038	2036.12	6680.2
Putnam, 1920	41 12 19.775 86 25 09.877	347 14 43.2	167 14 51.7	Posey	3.1327223	1357.45	4453.6
Culver, 1920	41 13 06.019 86 25 05.577	4 00 59.9	184 00 57.1	Putnam	3.1553659	1430.10	4691.9
Randolf, 1920	41 13 15.543 86 24 44.722	58 50 13.1	238 49 59.4	Culver	2.7541389	567.73	1862.6
Riple, 1920	41 14 13.201 86 23 39.790	40 22 41.4	220 21 58.6	Randolf	3.3682302	2334.70	7659.8
Rush, 1920	41 14 27.422 86 23 27.565	32 58 51.3	212 58 43.2	Riple	2.7184918	522.99	1715.8
Hibbard, 1920	41 15 23.070 86 22 57.671	22 04 22.9	202 04 03.2	Rush	3.2677415	1852.43	6077.5
Spencer, 1920	41 17 59.098 86 21 32.552	22 22 40.3	202 21 44.2	Hibbard	3.7164254	5205.06	17076.9
Twin, 1920	41 18 18.509 86 21 26.401	13 26 28.6	193 26 24.5	Spencer	2.7893431	615.66	2019.9
Joseph, 1920	41 19 49.471 86 19 56.400	36 43 49.6	216 42 50.2	Twin	3.5441812	3500.91	11485.9
Starke, 1920	41 19 56.171 86 19 43.946	54 29 07.7	234 28 59.5	Joseph	2.5511926	355.79	1167.3
Stuben, 1920	41 20 16.722 86 18 55.374	60 41 48.4	240 41 16.3	Starke	3.1123385	1295.21	4249.4
Plymouth, 1920	41 20 24.637 86 18 50.731	23 51 14.0	203 51 10.9	Stuben	2.4264732	266.98	875.9
Sullivan, 1920	41 21 09.299 86 18 51.522	359 14 02.8	179 14 03.3	Plymouth	3.1392242	1377.92	4520.7
Switzerland, 1920	41 22 21.061 86 18 52.640	359 19 39.5	179 19 40.3	Sullivan	3.3451770	2214.00	7263.8
Harris, 1920	41 24 02.320 86 18 29.496	9 46 08.8	189 45 53.5	Switzerland	3.5010278	3169.77	10399.5
Tippecanoe, 1920	41 25 00.473 86 18 16.975	9 12 31.8	189 12 23.5	Harris	3.2594622	1817.45	5962.8
Lapaz, 1920	41 27 00.036 86 17 49.391	9 51 09.0	189 50 50.8	Tippecanoe	3.5733035	3743.72	12282.5
Union, 1920	41 30 13.585 86 17 06.021	9 34 11.6	189 33 42.9	Lapaz	3.7821334	6055.27	19866.3
Mourhess, 1920	41 30 38.757 86 16 53.964	19 48 11.5	199 48 03.5	Union	2.9166469	825.37	2707.9
Aman, 1920	41 31 05.265 86 16 55.777	357 03 27.2	177 03 28.4	Mourhess	2.9132066	818.85	2686.5

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
States, 1920	41 32 07.840 86 16 37.857	12 08 51.3	192 08 39.4	Aman	3.2954960	1974.68	6478.6
Hilberry, 1920	41 34 22.976 86 16 37.964	359 57 57.4	179 57 57.5	States	3.6200382	4169.06	13678.0
Peacock, 1920	41 36 18.388 86 16 38.840	359 40 23.5	179 40 24.1	Hilberry	3.5515266	3560.63	11681.8
Wehr, 1920	41 36 45.760 86 16 28.961	15 09 29.3	195 09 22.8	Peacock	2.9419472	874.88	2870.3
Lloyd, 1920	41 38 24.509 86 15 17.782	28 24 47.3	208 24 00.1	Wehr	3.5395224	3463.56	11363.4
Studebaker, 1920	41 38 38.165 86 15 09.726	23 52 14.2	203 52 08.9	Lloyd	2.6634287	460.71	1511.5
Griffith, 1920	41 38 51.255 86 15 07.640	6 48 54.2	186 48 52.8	Studebaker	2.6092952	406.72	1334.4
Indiana, 1920	41 39 28.188 86 15 08.476	359 01 38.1	179 01 38.7	Griffith	3.0567496	1139.59	3738.8
South Bend, 1920	41 39 29.679 86 14 05.749	88 11 26.2	268 10 44.5	Indiana	3.1619905	1452.08	4764.0
Bud, 1920	41 39 40.820 86 14 05.930	359 17 59.6	179 17 59.7	South Bend	2.5362431	343.75	1127.8
Lincoln, 1920	41 39 28.547 86 13 37.047	119 32 24.5	299 32 05.3	Bud	2.8854034	768.07	2519.9
South Bend west base, 1920.	41 39 25.237 86 13 11.720	99 53 13.5 313 08 18.9	279 52 56.7 133 08 49.3	Lincoln Penn. (U. S. L. S.).	2.7744008 3.1618463	594.84 1451.60	1951.6 4762.5
South Bend east base, 1920.	41 39 26.893 86 12 02.957	88 10 04.2 27 00 37.5	268 09 18.5 207 00 22.2	South Bend west base. Penn. (U. S. L. S.).	3.2019018 3.0687272	1591.85 1171.46	5222.6 3843.4
Supplementary points.							
Queenville schoolhouse, flagpole, 1920.[1]	39 03 01.71 85 40 41.07	311 25 40 129 14 22	131 26 18 309 13 35	Benton Boon	3.287721 3.363185	1939.6 2307.7	6364 7571
Queenville schoolhouse, cupola, 1920.[1]	39 03 02.03 85 40 40.05	312 07, 49 128 18 37	132 08 27 308 18 10	Benton Blackfork	3.285116 3.112070	1928.0 1294.4	6325 4247
Columbus Courthouse, center of tower, 1920.	39 12 04.151 85 55 16.577	162 55 30.5 156 35 23.5 170 44 17.6	342 55 27.4 336 34 56.5 350 44 14.0	Columbus Clark Clay	2.610884 3.411579 2.933124	408.2 2579.8 857.3	1339 8464 2813
Columbus Lutheran Church, spire, 1920.	39 12 20.573 85 55 10.210	139 26 16.4 147 40 22.1 311 31 30.2	319 26 08.7 327 39 51.0 131 33 21.0	Clay Clark Cass	2.650428 3.342885 3.749942	447.1 2202.3 5622.7	1467 7225 18447
Edinburg Cabinet Co., water tank, 1920.	39 20 56.237 85 57 51.181	163 13 07.2 315 37 04.7 348 31 49.5	343 12 36.2 135 37 06.6 168 32 16.7	Daviess Edinburg Clinton	3.607545 2.019154 3.714959	4050.8 104.5 5187.5	13290 343 17019
Edinburg Christian Church, steeple, 1920.[1]	39 21 05.38 85 58 00.07	346 56 32 165 06 04	166 57 05 345 05 39	Clinton Daviess	3.741015 3.570713	5508.3 3721.5	18072 12210
Edinburg Cutsinger Grain Elevator Co., flagpole, 1920.	39 21 19.195 85 57 53.466	350 43 28.2 160 37 32.1 167 19 14.9	170 43 31.6 340 37 02.6 347 19 11.9	Edinburg Daviess Crawford	2.899298 3.526424 2.712082	793.0 3360.7 515.3	2602 11026 1691

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Precise traverse—North Vernon to South Bend—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Supplementary points—Contd.	° ′ ″	° ′ ″	° ′ ″				
Franklin Masonic Home, water tower, 1920.[1]	39 28 18.62 86 02 42.07	159 47 54 302 45 55	339 47 24 122 46 47	Elkhart..... Delaware.....	3.512763 3.362644	3256.6 2304.9	10684 7562
Franklin College, steeple, 1920.[1]	39 28 45.70 86 02 50.94	157 39 40 314 05 00	337 39 15 134 05 57	Elkhart..... Delaware.....	3.380464 3.476135	2401.4 2993.2	7879 9820
Franklin Courthouse, dome, 1920.[1]	39 28 48.15 86 03 18.56	173 17 00 307 30 55	353 16 53 127 32 10	Elkhart..... Delaware.....	3.334520 3.549411	2160.3 3543.3	7088 11625
Franklin Presbyterian Church, steeple, 1920.[1]	39 28 54.40 86 03 13.35	169 04 01 311 11 16	349 03 51 131 12 28	Elkhart..... Delaware.....	3.298664 3.552549	1989.1 3569.0	6526 11709
Franklin Mfg. Co., water tank, 1920.	39 29 25.350 86 02 53.390	325 55 53.2 326 14 43.3 139 27 16.9	145 57 00.4 146 15 42.1 319 26 54.2	DeKalb..... Delaware..... Elkhart.....	3.653598 3.599361 3.118563	4504.0 3975.2 1313.9	14777 13042 4311
Whiteland M. E. Church, steeple, 1920.[1]	39 32 59.17 86 05 02.13	178 44 10 317 10 01	358 44 09 137 10 22	Fayette..... Whiteland....	3.282848 3.060558	1918.0 1149.6	6293 3772
Whiteland Schoolhouse, cupola, 1920.[1]	39 33 02.52 86 04 48.83	168 47 20 333 52 12	348 47 10 153 52 24	Fayette..... Whiteland....	3.267106 3.022809	1849.7 1053.9	6069 3458
Greenwood, Indian Canning Co., water tank, 1920.[1]	39 36 45.70 86 05 58.22	359 40 05 153 08 39	179 40 05 333 08 24	Floyd..... Greenwood....	2.911158 3.101938	815.0 1264.6	2674 4149
Tipton Catholic Church, spire, 1920.[1]	40 17 09.10 86 02 12.80	344 10 39 9 44 19	164 10 46 189 44 17	Jasper..... Tipton.....	2.998904 2.497943	997.5 314.7	3273 1032
Kewanna Baptist Church, spire, 1920.	41 01 07.185 86 24 34.906	170 48 55.1 186 26 31.8 350 17 05.9 355 45 30.4	350 48 43.8 6 26 33.0 170 17 17.4 175 45 32.1	Ohio..... Kewanna..... Newton..... Noble.....	3.399687 2.591730 3.387415 2.921732	2510.1 390.6 2440.1 835.1	8235 1281 8006 2740
Plymouth schoolhouse, flagpole, 1920.[1]	41 20 30.70 86 18 48.01	21 39 30 176 04 51	201 39 25 356 04 48	Stuben..... Sullivan.....	2.666334 3.076901	463.8 1193.7	1522 3916
Plymouth Courthouse, cupola, 1920.[1]	41 20 37.76 86 18 40.98	27 16 55 165 51 40	207 16 46 345 51 33	Stuben..... Sullivan.....	2.863457 3.001466	730.2 1003.4	2396 3292

Triangulation by United States Lake Survey.

Principal points.							
Reading (U. S. L. S.) (Mich.), 1878.	41 50 05.941 84 44 30.767	218 40 45.83 248 38 10.89 272 36 43.09	38 44 26.44 68 49 39.85 92 47 04.03	Hillsdale (U. S. L. S.). Wheatland (U. S. L. S.). Pittsford (U. S. L. S.).	4.0858344 4.4071932 4.3326095	12185.25 25538.37 21508.47	39977.8 83787.1 70565.7
Quincy (U. S. L. S.), 1878.	41 57 39.900 84 55 19.250	313 04 30.70	133 11 43.76	Reading (U. S. L. S.).	4.3114278	20484.61	67206.6
Fremont (U. S. L. S.), 1878.	41 42 31.974 84 57 58.193	187 26 39.72 233 01 03.97	7 28 25.73 53 10 01.85	Quincy (U. S. L. S.). Reading (U. S. L. S.).	4.4510296 4.3677768	28250.73 23322.59	92685.9 76517.5
Bronson (U. S. L. S.), 1878.	41 51 22.352 85 14 38.196	246 19 51.45 305 13 40.97	66 32 45.56 125 24 47.28	Quincy U. S. L. S.). Fremont (U. S. L. S.).	4.4644947 4.4518276	29140.35 28302.68	95604.6 92856.4

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Triangulation by United States Lake Survey—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Mongo (U.S.L.S.), 1878.	41 41 34.461 85 16 07.917	186 30 33.35	6 31 33.12	Bronson (U. S. L. S.).	4.2613964	18255.61	59893.6
		265 52 16.26	86 04 21.19	Fremont (U. S. L. S.).	4.4024194	25259.19	82871.2
Sherman (U. S. L. S.), 1878.	41 50 48.490 85 27 11.662	266 29 25.58	86 37 48.29	Bronson (U. S. L. S.).	4.2408591	17412.42	57127.2
		318 02 57.26	138 10 19.41	Mongo (U. S. L. S.).	4.3609882	22960.86	75330.8
Van Buren (U. S. L. S.), 1878.	41 42 29.696 85 36 45.963	220 42 15.32	40 48 37.94	Sherman (U.S. L. S.).	4.3078330	20315.76	66652.6
		273 17 32.39	93 31 15.98	Mongo (U. S. L. S.).	4.4575353	28677.11	94084.8
Porter (U. S. L. S.), 1878.	41 49 22.398 85 45 59.318	264 04 00.81	84 16 32.94	Sherman (U.S. L. S.).	4.4175528	26154.89	85809.8
		314 50 17.20	134 56 25.78	Van Buren (U. S. L. S.).	4.2562749	18041.59	59191.4
Jefferson (U. S. L. S.), 1878.	41 40 59.961 85 48 29.310	192 35 15.27	12 36 55.15	Porter (U. S. L. S.).	4.2009547	15883.81	52112.1
		238 16 49.53	58 31 00.54	Sherman (U.S. L. S.).	4.5397135	34650.82	113683.6
		260 16 28.74	80 24 16.59	Van Buren (U. S. L. S.).	4.2174355	16498.16	54127.7
Calvin (U. S. L. S.) (Mich.), 1878.	41 50 10.298 85 55 26.400	268 07 00.86	88 25 51.23	Sherman (U. S. L. S.).	4.5923794	39118.25	128340.5
		276 23 26.40	96 29 44.60	Porter (U. S. L. S.).	4.1195588	13169.18	43205.9
		298 40 07.23	118 52 33.64	Van Buren (U.S.L.S.).	4.4701643	29523.26	96860.9
		330 23 14.74	150 27 52.53	Jefferson (U. S. L. S.).	4.2905332	19522.40	64049.7
Milton (U. S. L. S.) (Mich.), 1877.	41 48 09.287 86 10 28.965	259 45 19.07	79 55 20.89	Calvin (U. S. L. S.).	4.3255739	21162.84	69431.8
		293 21 24.26	113 36 02.87	Jefferson (U. S. L. S.).	4.5217379	33245.89	109074.2
Penn (U. S. L. S.), 1877.	41 38 53.064 86 12 25.947	188 56 35.87	8 57 53.73	Milton (U. S. L. S.).	4.2398542	17372.18	56995.2
		228 20 12.48	48 31 31.28	Calvin (U. S. L. S.).	4.4981651	31489.45	103311.6
		263 08 57.81	83 24 52.86	Jefferson (U. S. L. S.).	4.5246042	33466.03	109796.5
Carlisle (U. S. L. S.), 1877.	41 40 05.097 86 29 38.037	240 32 03.49	60 44 48.83	Milton (U. S. L. S.).	4.4838462	30468.16	99961.0
		275 13 17.16	95 24 43.17	Penn (U. S. L. S.).	4.3799064	23983.16	78684.8
Bertrand (U. S. L. S.) (Mich.), 1877.	41 46 44.897 86 22 39.558	261 09 31.01	81 17 37.89	Milton (U. S. L. S.).	4.2322103	17069.09	56000.8
		315 41 02.50	135 47 50.80	Penn (U. S. L. S.).	4.3080396	20325.42	66684.3
		38 08 31.74	218 03 53.23	Carlisle (U. S. L. S.).	4.1952049	15674.91	51426.8
Galena (U. S. L. S.), 1877.	41 41 45.830 86 40 31.367	249 28 10.12	69 40 03.65	Bertrand (U. S. L. S.).	4.4221173	26431.23	86716.5
		281 33 40.62	101 40 55.08	Carlisle (U. S. L. S.).	4.1882843	15427.10	50613.7
Bald Tom (U. S. L. S.), 1874.	41 54 19.287 86 35 58.667	307 10 29.62	127 19 22.69	Bertrand (U. S. L. S.).	4.3647604	23161.16	75987.9
		341 31 13.80	161 35 27.44	Carlisle (U. S. L. S.).	4.4437412	27780.57	91143.4
		15 10 45.19	195 07 43.42	Galena (U. S. L. S.).	4.3817149	24083.24	79013.1

GEOGRAPHIC POSITIONS—Continued.

Triangulation by United States Lake Survey—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Principal points—Continued.	° ′ ″	° ′ ″	° ′ ″				
Michigan City (U. S. L. S.), 1877.	41 44 07.738 86 52 20.028	230 06 48.36	50 17 42.73	Bald Tom (U. S. L. S.).	4.4695024	29478.30	96713.4
		284 53 49.97	105 01 41.54	Galena (U. S. L. S.).	4.2293462	16956.89	55632.7
Springville (U. S. L. S.), 1874.	41 39 52.765 86 44 29.845	125 55 52.70	305 50 39.93	Michigan City (U. S. L. S.).	4.1277262	13419.19	44026.1
		203 46 33.92	23 52 14.54	Bald Tom (U. S. L. S.).	4.4657404	29224.05	95879.2
Otis (U. S. L. S.), 1874.	41 35 18.601 86 52 35.177	181 13 43.23	1 13 53.30	Michigan City (U. S. L. S.).	4.2129434	16328.39	53570.7
		232 58 49.99	53 04 12.38	Springville (U. S. L. S.).	4.1480740	14062.87	46137.9
Millers (U. S. L. S.), 1874.	41 36 55.380 87 14 17.883	246 14 43.43	66 29 19.69	Michigan City (U. S. L. S.).	4.5221095	33274.34	109167.6
		275 31 55.48	95 46 20.43	Otis (U. S. L. S.).	4.4816561	30314.90	99458.1
Shot Tower (U. S. L. S.) (Ill.), 1874.	41 53 11.400 87 38 29.391	284 26 44.77	104 57 31.04	Michigan City (U. S. L. S.).	4.8201231	66088.08	216824.0
		311 47 10.88	132 03 17.43	Millers (U. S. L. S.).	4.6538965	45070.93	147870.2
Supplementary points.							
South Bend, Notre Dame Univ. dome (U. S. L. S.), 1877.	41 42 10.94 86 14 20.15	79 43 16.1	259 33 05.6	Carlisle (U. S. L. S.).	4.334067	21580.8	70803
		126 15 55.9	306 10 23.4	Bertrand (U. S. L. S.).	4.155475	14304.6	46931
South Bend standpipe (U. S. L. S.), 1877.	41 40 31.32 86 14 51.80	87 49 19.2	267 39 29.9	Carlisle (U. S. L. S.).	4.312113	20517.0	67313
		136 52 29.8	316 47 18.4	Bertrand (U. S. L. S.).	4.198726	15802.5	51845
New Carlisle, M. E. Church steeple (U. S. L. S.), 1877.	41 42 25.59 86 30 40.06	284 25 26.8	104 37 34.3	Penn (U. S. L. S.).	4.417356	26143.0	85771
		341 40 55.7	161 41 37.0	Carlisle (U. S. L. S.).	3.659511	4565.7	14979
New Carlisle, Christian Church spire (U. S. L. S.), 1877.	41 42 22.26 86 30 41.10	233 53 33.7	53 58 54.3	Bertrand (U. S. L. S.).	4.138766	13764.7	45160
		284 11 33.3	104 23 41.5	Penn (U. S. L. S.).	4.417318	26140.8	85764
Michigan City, high school (U. S. L. S.), 1877.	41 42 51.74 86 53 46.82	220 32 26.8	40 33 24.6	Michigan City U. S. L. S.)	3.489351	3085.7	10124
		293 09 08.8	113 15 19.2	(Springville (U. S. L. S.).	4.146570	14014.3	45979
T. 38 N., R. 14 E., NW. cor. of sec. 31 (U. S. L. S.).	41 42 55.82 84 58 15.23						
T. 37 N., R. 11 E., cor. of secs. 4, 5, 8, 9 (U. S. L. S.).	41 41 08.35 85 16 22.52						
T. 38 N., R. 8 E., SW. cor. of NW. ¼ of sec. 33 (U. S. L. S.).	41 42 15.97 85 37 12.85						
T. 37 N., R. 6 E., cor. of secs. 2, 3, 10, 11 (U. S. L. S.).	41 40 54.76 85 48 42.76						
T. 37 N., R. 3 E., cor. of secs. 17, 18, 19, 20 (U. S. L. S.).	41 39 04.32 86 12 56.53						

GEOGRAPHIC POSITIONS—Continued.

Triangulation by United States Lake Survey—Continued.

Station.	Latitude and longitude.	Azimuth.	Back azimuth.	To station.	Distance.		
					Log (meters).	Meters.	Feet.
Supplementary points—Contd.	° ′ ″	° ′ ″	° ′ ″				
T. 37N., R. 1 W., cor. of secs. 2, 3, 10, 11 (U. S. L. S.).	41 40 46.34 86 30 22.84						
T. 38 N., R. 2 W., SW. cor. of SE. ¼ of SW. ¼ of sec. 32 (U.S.L.S.).	41 41 38.96 86 40 32.67						
T. 37 N., R. 3 W., SE. cor. of sec. 10 (U. S. L. S.).	41 39 52.19 86 44 18.96						
T. 36 N., R. 4 W., NW. cor. of sec. 10 (U. S. L. S.).	41 35 32.74 86 52 38.21						
T. 36 N., R. 7 W., SE. cor. of NE. ¼ of sec. 6 (U. S. L. S.).	41 36 05.01 87 15 39.73						
St. John's Church spire (U. S. L. S.), 1874.	41 42 45.323 86 53 58.783	291 58 34.76	112 04 53.15	Springville (U. S. L. S.).	4.1520991	14193.81	46567.5
		352 00 05.57	172 01 01.13	Otis (U. S. L. S.).	4.1435502	13917.15	45659.8
City West (U. S. L. S.), 1908.	41 39 44.582 87 03 22.829	246 48 10.27	66 54 25.40	St. John's Church spire (U.S. L. S.).	4.1518763	14186.53	46543.6
		298 37 59.66	118 45 09.87	Otis (U. S. L. S.).	4.2327770	17091.37	56073.9
		358 46 40.5	.....	Chesterton church spire.	.....	.....	.....
		357 43 45	.....	Chesterton Catholic church spire.	.....	.....	.....
Field (U. S. L. S.), 1908.	41 42 18.957 86 56 45.159	258 02 36.09	78 04 26.79	St. John's Church spire (U. S. L. S.).	3.5945664	3931.57	12898.8
		335 56 10.98	155 58 57.10	Otis (U. S. L. S.).	4.1522979	14200.31	46588.8
		62 39 37.43	242 35 12.97	City West (U.S. L.S.).	4.0152518	10357.42	33981.0
		227 17 55	.....	East Pierhead light.	.....	.....	.....
		275 38 49.7	.....	Prison W. W. Tower.	.....	.....	.....
Michigan City (U. S. L. S.), (1908).	41 44 07.742 86 52 20.027	1 13 53.13	181 13 43.06	Otis (U. S. L. S.).	4.2129466	16328.51	53571.1
		41 55 25.82	221 54 19.79	St. John's Church spire (U. S. L. S.).	3.5336422	3416.98	11210.5
		61 19 04.76	241 16 08.32	Field (U. S. L. S.).	3.8443152	6987.39	22924.5
		28 58 07.9	.....	Hanna stack.	.....	.....	.....
		42 16 35	.....	St. Paul's Church spire.	.....	.....	.....
Hoosier (U. S. L. S.), 1908.	41 43 01.143 86 54 57.125	289 53 15.15	109 53 53.97	St. John's Church spire (U. S. L. S.).	3.1566345	1434.28	4705.6
		62 29 08.33	242 27 56.45	Field, (U. S. L. S.).	3.4496882	2816.36	9240.0
West pierhead light (U. S. L. S.), 1908.	41 43 35.828 86 54 35.985	268 32 23.69	88 32 59.59	Yankee (U. S. L. S.).	3.0959189	1247.15	4091.7
		24 32 43.33	204 32 29.26	Hoosier (U. S. L. S.).	3.0705471	1176.38	3859.5

Table of elevations, thirty-ninth parallel.

Station.	Point to which elevation refers.	Elevation.		Station.	Point to which elevation refers.	Elevation.	
Class 1.		*Meters.*	*Feet.*	*Class 2.*		*Meters.*	*Feet.*
Glasgow	Top of surface stone.	302.39	992.1	Blind Asylum	Surface mark.	159.1	522
				Blocher	do	213.8	701
Holton north base	do	281.46	923.4	Cox, 1879	do	229.96	754.5
Holton south base	do	278.72	914.4	Finley	do	313.0	1027
Louisville north base.	do	136.546	447.98	Marysville	do	216.4	710
Louisville south base.	do	144.440	473.88	Miller	do	281.9	925
				O. & M	do	197.8	649
				Popp	do	281.4	923
Lutz	Surface mark.	183.376	601.63	Riley	do	277.3	910
Rariden	do	277.53	910.5	Six Mile	do	284.7	934
Tripp	do	226.14	741.9				
				Stout	do	225.7	740
				Summit, 1886	do	295.2	968
				Williams	do	296.8	974

ELEVATIONS, U. S. LAKE SURVEY STATIONS.

The elevations given in the following table all refer to stations of the U. S. Lake Survey. The data for forming this table were taken from the descriptions of the stations as furnished for this publication by that organization. The method by which these elevations were determined is not known, nor is the accuracy except as it seems to be indicated by the decimal place to which the elevation is given.

The elevations as given in the descriptions furnished this Bureau were referred to the mean elevation of Lake Michigan. For the following table each elevation was increased by 581.3 feet, which is the height of the mean level of Lake Michigan above mean sea level as determined by observations between January 1, 1860, and December 31, 1875. (See Professional Papers No. 24, Corps of Engineers, U. S. Army, p. 609.)

Table of elevations, United States Lake Survey.

Station.	Point to which elevation refers.	Elevation.		Station.	Point to which elevation refers.	Elevation.	
		Meters.	*Feet.*			*Meters.*	*Feet.*
Bald Tom (U. S. L. S.)	Ground at station.	250.36	821.4	Mongo (U. S. L. S.)	Ground at station.	312.97	1026.8
Bertrand (U. S. L. S.)	do	285.96	938.2	Penn (U. S. L. S.)	do	271.46	890.6
Bronson (U. S. L. S.)	do	304.10	997.7	Porter (U. S. L. S.)	do	289.47	949.7
Calvin (U. S. L. S.)	do	308.03	1010.6	Quincy (U. S. L. S.)	do	323.15	1060.2
Carlisle (U. S. L. S.)	do	278.44	913.5	Reading (U. S. L. S.)	do	368.35	1208.5
Fremont (U. S. L. S.)	do	347.93	1141.5	Sherman (U. S. L. S.)	do	316.08	1037.0
Galena (U. S. L. S.)	do	291.76	957.2	Van Buren (U. S. L. S.	do	289.87	951.0
Jefferson (U. S. L. S.)	do	295.53	969.6				
Millers (U. S. L. S.)	do	216.1	709				
Milton (U. S. L. S.)	do	272.92	895.4				

DESCRIPTIONS OF STATIONS.

This list of descriptions of stations may be conveniently consulted by reference to the illustrations at the end of this publication or to the index. All azimuths given in the descriptions are reckoned contin-

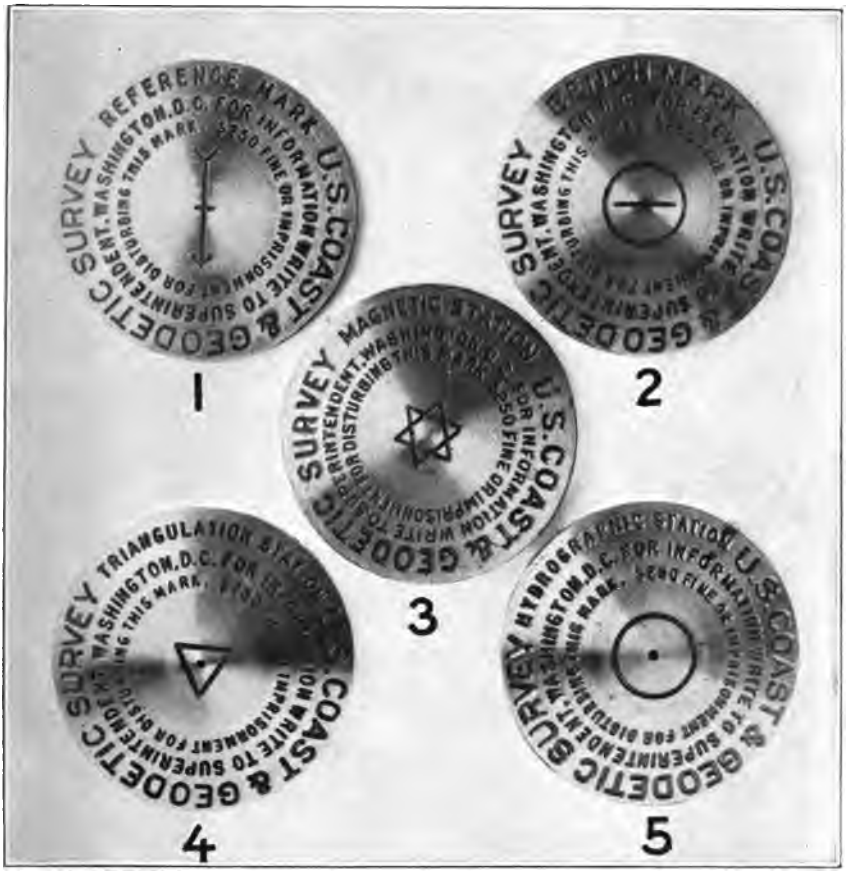

Fig. 1.—STANDARD MARKS OF THE U. S. COAST AND GEODETIC SURVEY.

1. Reference mark.
2. Bench mark.
3. Magnetic station mark.
4. Triangulation station mark.
5. Hydrographic station mark.

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uously from true south around by west to 360°, south being 0°, west 90°, north 180°, and east 270°. Where magnetic azimuths are given they are indicated as such. All distances between station and reference marks are horizontal unless otherwise stated in the description. The name of the station and the year are stamped on the traverse station marks.

In general, except where the contrary is specifically stated, the surface and underground mark are not in contact, so that a disturbance of the surface mark will not necessarily affect the underground mark. The underground mark should be resorted to only in cases where there is evidence that the surface mark has been disturbed.

The name and dates given in each description immediately after the county refer to the chief of party by whom the station was established, the date of the establishment of the station, and the date when the station was last recovered.

Any person who finds that one of the stations herein described has been disturbed or that the description no longer fits the facts is requested to send such information to the Director, U. S. Coast and Geodetic Survey, Washington, D. C.

The standard station and reference marks (see fig. 1) referred to in the following descriptions and notes consist of a disk and shank of brass cast in one piece. The disk of the station mark is 90 mm. in diameter, with a hole at the center surrounded by a 20 mm. equilateral triangle, and has the following inscribed legend: "U. S. Coast and Geodetic Survey Triangulation Station. For information write to the superintendent, Washington, D. C. $250 fine or imprisonment for disturbing this mark." The shank is 17 mm. in diameter and 80 mm. long, with several grooves cut around it to give a secure anchorage in concrete.

The standard reference mark, shown in figure 1, is the same size and shape as the station mark, with an arrow on the top in place of the triangle, which, when properly set, points to the station. The legend is the same, except the words "reference mark" take the place of the words "triangulation station."

STANDARD NOTES ON THE MARKING OF STATIONS.

SURFACE MARKS.

Note 1.—A standard bronze tablet set in the top of (*a*) a square block or post of concrete, (*b*) a concrete cylinder, (*c*) an irregular mass of concrete.

Note 2.—A standard bronze tablet wedged in a drill hole in outcropping bedrock, (*a*) and surrounded by a triangle chiseled in the rock, (*b*) and surrounded by a circle chiseled in the rock, (*c*) at the intersection of two lines chiseled in the rock.

Note 3.—A standard bronze tablet set in concrete in a depression in outcropping bedrock.

Note 4.—A standard bronze tablet wedged in a drill hole in a bowlder.

Note 5.—A standard bronze tablet set in concrete in a depression in a bowlder.

Note 6.—A standard bronze tablet set in concrete at the center of the top of a tile (*a*) which is embedded in the ground, (*b*) which is surrounded by a mass of concrete, (*c*) which is fastened by means of concrete to the upper end of a long wooden pile driven into the marsh, (*d*) which is set in a block of concrete and projects from 12 to 20 inches above the block.

UNDERGROUND MARKS.

Note 7.—A block of concrete 3 feet below the ground containing at the center of its upper surface (*a*) a standard bronze tablet, (*b*) a copper bolt projecting slightly above the concrete, (*c*) an iron nail with the point projecting above the concrete, (*d*)

a glass bottle with the neck projecting a little above the concrete, (*e*) an earthenware jug with the mouth projecting a little above the concrete.

Note 8.—In bedrock, (*a*) a standard bronze tablet wedged in a drill hole, (*b*) a standard bronze tablet set in concrete in a depression, (*c*) a copper bolt set in cement in a drill hole or depression, (*d*) an iron spike set point up in cement in a drill hole or depression.

Note 9.—In a bowlder 3 feet below the ground, (*a*) a standard bronze tablet wedged in a drill hole, (*b*) a standard bronze tablet set in concrete in a depression, (*c*) a copper bolt set with cement in a drill hole or depression, (*d*) an iron spike set with cement in a drill hole or depression.

Note 10.—Embedded in earth 3 feet below the surface of the ground; (*a*) a bottle in an upright position, (*b*) an earthenware jug in an upright position, (*c*) a brick in horizontal position with a drill hole in its upper surface.

REFERENCE MARKS.

Note 11.—A standard bronze tablet with the arrow pointing toward the station set at the center of the top of (*a*) a square block or post of concrete, (*b*) a concrete cylinder, (*c*) an irregular mass of concrete.

Note 12.—A standard bronze tablet with the arrow pointing toward the station, (*a*) wedged in a drill hole in outcropping bedrock, (*b*) set in concrete in a depression in outcropping bedrock, (*c*) wedged in a drill hole in a bowlder, (*d*) set in concrete in a depression in a bowlder.

Note 13.—A standard bronze tablet with the arrow pointing toward the station set in concrete at the center of the top of a tile, (*a*) which is embedded in the ground (*b*) which is surrounded by a mass of concrete, (*c*) which is fastened by means of concrete to the upper end of a long wooden pile driven into the marsh, (*d*) which is set in a block of concrete and projects from 12 to 20 inches above the block.

WITNESS MARKS.

Note 14.—A conical mound of earth surrounded by a circular trench.

Note 15.—A tree marked with (*a*) a triangular blaze with a nail at the center and each apex of the triangle, (*b*) a square blaze with a nail at the center and each corner of the square, (*c*) a blaze with a standard disk reference mark set at its center into the tree.

ADDITIONAL NOTES, USED IN THIS PUBLICATION.

Note 16.—The station is marked by two stone posts, one at the surface of the ground and the other 3 feet deep directly below the surface mark. Both posts are in an upright position. This type of marking was employed by the U. S. Lake Survey.

Note 17.—The station is marked by a nail set in concrete at the center of the top of a tile 6 inches in diameter and 2 feet long. The tile is filled with concrete and is set flush with the surface of the ground. The underground mark is an earthenware pyramid set about 2½ or 3 feet below the surface. There are four reference marks similar to the surface mark at the station, except the tiles are only 4 inches in diameter. They are north, east, south, and west from the station at distances given in the description.

Note 18.—The station is marked by a cross in the top of a stone post 6 inches square and 30 inches long inscribed with the letters U.S.C. & G.S. The underground mark is an earthenware pyramid with edges about 6 inches long marked with the raised letters U. S. C. S. The three reference marks are stone posts 6 inches square and 30 inches long set at the distances and directions as given in the description.

Note 19.—The station is marked by a limestone post 2 feet in length and dressed to 5 inches square at the top inscribed with a cross and the letters U. S. C. & G. S. It is also marked 2 feet below the surface of the ground by a copper wire set in cement in the mouth of a black bottle which in turn is set at the center of a 10-inch tile filled with concrete. There are three reference marks each consisting of a stone similar to the one marking the station, except that the top is inscribed with a diagonal arrow pointing toward the station.

PRECISE TRIANGULATION ALONG THE THIRTY-NINTH PARALLEL.

PRINCIPAL POINTS.

Dry Ridge (Grant County, Ky., A. T. Mosman., 1889).—About one-third mile east of the railway station at Dry Ridge on the north side of the turnpike to Knoxville. There is a bend in the road about 150 meters west of the station and but for this bend

the station would be in the middle of the road, that is, it is in the prolongation of the straight part of the road west of the bend. The station is marked according to note 17[1] and the surface mark is surrounded by a block of concrete 2 feet deep and 16 inches in diameter. The reference marks are at the following distances and directions from the station: 1.82 meters north, 1.82 meters east, just north of the north road fence 15 meters south, and in the middle of a path 10.45 meters west. There is a house about 150 meters north of the station. An elm tree marked with a blaze is in the hollow on the north side of the turnpike 89.2 meters from the station in azimuth 81° 14′.

Tanner (Boone County, Ky., A. T. Mosman, 1889).—About 1½ miles from Florence and one-half mile west of the tollgate, on the Burlington pike, on land belonging to Noah Clore, nearly south of his house. The station is marked according to note 17.[1] The reference marks are at the following distances and directions from the station: 1.84 meters north, 1.84 meters east, 1.83 meters south, and 1.83 meters west. The corner stone at the corner of Noah Clore's and E. K. Tanner's lands is 18.5 meters from the station in azimuth 278° 52′.

Stow (Switzerland County, A. T. Mosman, 1890).—About 2 miles south of East Enterprise, in the southeast corner of NW. ¼ sec. 9, T. 3 N., R. 2 W., on the west side of the pike between East Enterprise and Markland. The station is on land belonging to Uziel U. Stow, in the cleared field northeast of his house and just north of a clump of timber known as the deer park. It is 21.5 meters from the center of the pike, 32 meters south of the south edge of an apple orchard, and 27 meters northeast of a frog pond. The station is marked according to note 17.[1] The reference marks are at the following distances and directions from the station: 1.83 meters north, 1.83 meters east, 1.83 meters south, and 1.83 meters west.

Reizin (Ripley County, A. T. Mosman, 1889).—About 1 mile east of Elrod and about 300 meters south of the road from Elrod to Dillsboro, on land belonging to Joseph Beall about 12 meters east of the line fence between his land and that of Reizin Johnson. The station is marked according to note 17.[1] The reference marks are at the following distances and directions from the station: 1.82 meters north, 1.84 meters east, 1.82 meters south, and 11.9 meters west. The west reference mark is in the fence line mentioned above. A lone hickory tree, marked with a blaze and a triangle of nails, is 55.3 meters N. 24° 11′ E. from the station.

Culbertson (Switzerland County, A. T. Mosman, 1890).—About 11 miles by road in a northerly direction from Vevay, in Pleasant Township, in the northwest corner of SE. ¼ sec. 33, T. 5 N., R. 12 E., on land belonging to James Culbertson. The station is on the highest point of a pasture on the opposite side of the pike from Culbertson's house, about 200 meters from the pike, and about 15 meters east of the center of a road running south from the pike. The station is marked according to note 17.[1] The reference marks are at the following distances and directions from the station: 1.80 meters north, 1.87 meters east, 1.81 meters south, and 10.86 meters west. The west reference mark is in the fence line on the east side of the road.

Correct (Ripley County, A. T. Mosman, 1890).—About one-half mile north of Correct post office, in Johnson Township, in the southwest corner of SE. ¼ SE. ¼ sec. 27, T. 7 N., R. 11 E., on the west side of the county road from Correct to Versailles. The station is nearly on the line between sections 27 and 34. It is marked according to note 17.[1] The reference marks are located as follows: About 1 foot inside of the fence line on the west side of the road 7.27 meters east of the station, on the east side of the road 19.85 meters east of the station, in the fence line 9.21 meters south of the station, and about 1 foot inside of the fence on the west side of the road 20.25 meters from the station in azimuth 220° 43′. The north gable of Mr. Jackson's barn is 49.4 meters from the station in azimuth 285° 50′, and a walnut tree is 82.3 meters from the station in azimuth 172° 51′.

Glasgow (Ripley County, A. T. Mosman, 1890; 1906.—About 1¼ miles south of the town of Osgood, on the west side of the continuation of the road to Ashman & Glasgow's quarries on land belonging to Jasper S. Bilby, of the U. S. Coast and Geodetic Survey. The station is in the SE. ¼ SE. ¼ sec. 28, T. 8 N., R.11 E., 178.0 meters north and 28.7 meters west of the stone marking the southeast corner of the section. The station is marked according to note 17.[1] The reference marks are located as follows: West side of road 30.63 meters from the station in azimuth 226° 45′, west side of road 22.96 meters in azimuth 271° 37′, east side of road 34.43 meters in azimuth 271° 37′, and west side of road 27.94 meters from the station in azimuth 308° 43′. Five tons of stones were used in anchoring the legs of the tripod and scaffold.

[1] See pp. 27 and 28.

Green (Jennings County, G. A. Fairfield, 1890).—About 5 miles north of the town of Butlerville and 2 miles southwest of the town of Zenas, in Columbia Township, near the northeast corner of sec. 34, T. 8 N., R. 9 E., 282.6 meters west and 18.6 meters south of the stone marking the northeast corner of the section. The station is on land belonging to Samuel Rush and is marked according to note 17,[1] except that there are only three reference marks. The reference marks are in the fence line on the south side of the road along the north side of the section and are at following distances and azimuths from the station: 21.13 meters 131°, 13.08 meters 180° 30′, and 20.42 meters 233° 25′.

Holton north base (Ripley County, A. T. Mosman, 1890).—About 1 mile east of Holton, in Otter Creek Township, in the southeast corner of sec. 2, T. 7 N., R 10 E., on land belonging to Sam Cox, 28.9 meters south of the south rail of the Baltimore & Ohio Southwestern Railroad track. The station is marked by a cross and small drill hole in the top of a copper bolt set in the center of the top of a block of limestone 3 feet square and 2½ feet thick made up of two parts, one 9 inches thick and the other 21 inches thick, cemented together. This block rests on a concrete foundation 4 feet square and 1 foot thick, with a hole 1 foot square at the center to give access to the underground mark, which consists of a copper bolt in the top of a limestone post 6 inches square and 2 feet long. The surface mark projects about 6 inches above the ground and has its upper edges beveled. On this surface mark is a limestone shaft 3 feet high, 2 feet square at the base, 1 foot square at the top, with "U. S. COAST AND GEODETIC SURVEY" cut on the south face, "NORTH BASE" on the east face, and "HOLTON BASE LINE 1891" on the west face. Four reference marks, each consisting of a stone post 6 inches square and 2 feet long, with a copper bolt at the center of the top, are at the following distances and azimuths from the station: 15.0 meters 85° 54′, 14.95 meters 175° 54′, 15.00 meters 265° 54′, and 15.01 meters 355° 54′.

Holton south base (Ripley County, A. T. Mosman, 1890).—About 1½ miles north of New Marion, in Center Township, in the northwest corner of sec. 25, T. 7 N., R. 10 E., on land belonging to Mr. Hilson. The station is marked exactly the same as *Holton north base*, described above, with the exception that "SOUTH" is substituted for "NORTH" in the inscription on the limestone shaft. The reference marks are at the following distances and azimuths from the station: 13.02 meters 54° 37′, 16.67 meters 138° 34′, 15.73 meters 214° 39′, 11.75 meters 306° 56′. The second and third reference marks are in the fence line on the south side of the public road north of the station.

Mud Lick (Jefferson County, A. T. Mosman, 1890).—About 7 miles from Madison and one-half mile south of Mud Lick post office, in the southeast corner of NW. ¼ sec. 26, T. 5 N., R. 10 E., on land belonging to William H. Buckhannon. The station is on the west side of the Michigan road, which is very nearly on the half section line north and south of section 26, and is just north of the county road to Lancaster, which is on the half section line east and west of section 26. The station is marked according to note 17.[1] The reference marks are at the following distances and azimuths from the station: 32.7 meters 8° 08′, 44.16 meters 8° 08′, 50.44 meters 278° 04′, and 57.82 meters 305° 00′. The east edge of the chimney on Buckhannon's house is in azimuth 190° 15′ from the station, the east edge of the chimney on Denney's house is in azimuth 212° 38′, and the east edge of the chimney on a house south of the station is in azimuth 355° 28′.

Stout (Jefferson County, G. A. Fairfield, 1890; 1914).—About 5 miles southwest of the town of Dupont, about the same distance northeast of the town of Paris, and about 1 mile north of Neils Creek post office, on land belonging to Mr. Shawhan, a son-in-law of A. O. Stout, who owned the land when the station was established. The station is about one-third mile north of Shawhan's house, near the northeast corner of sec. 25, T. 5 N., R. 8 E. The north line of this section is also the county line between Jefferson and Jennings Counties. The station is marked according to note 17,[1] except that there are only three reference marks and they have the numbers 1, 2, and 3 cut in the tops. They are in the fence line west of the station and are at the following distances and magnetic bearings from the station: No. 1, 12.48 meters S. 43° 12′ W.; No. 2, 8.45 meters S. 86° 48′ W.; and No. 3, 14.00 meters N. 36° 41′ W. The stone marking the northwest corner of NE. ¼ NE. ¼ sec. 25 is 13.16 meters N. 39° 55′ W. (mag.) from the station.

Tripp (Jennings County, G. A. Fairfield, 1890; 1920).—About 1 mile southwest of North Vernon, 100 meters southeast of the North Vernon-Seymour pike on land owned by Thomas Noon, about 100 meters south of his house and 100 meters east of an old barn, about 10 meters south of the north line of sec. 4, T. 6 N., R. 8 E. The station, underground, and reference marks are bronze tablets set in concrete as described in

[1] See pp. 27 and 28.

notes 1a, 7a, and 11a.[1] The reference marks are in the fence line to the north of the station. The first, in which the top of the bronze cap has been cut off leaving the stem in the concrete, is distant 34.56 meters in azimuth 110° 38′, and the second is distant 29.93 meters in azimuth 257° 08′. A large concrete post at the eastern end of the row of posts is distant about 100 meters in azimuth 98° 38′, William Day's house distant about 150 meters is in azimuth 127°, and Noon's house 193°.

Miller (Jennings County, G. A. Fairfield, 1889; 1914).—About 2½ miles south of Brownstown in a small clearing known as the "Old Ike Miller peach orchard," on top of a ridge about 1 mile east of the main road from Brownstown, on land belonging to Miss Caroline Sanders. The station is in the SW. ¼ SW. ¼ NW. ¼ sec. 25, T. 5 N., R. 4 E., about 100 meters northwest of a small cabin on the Sanders place. The station is marked according to note 18.[1] When visited in 1914 one reference mark was found in good condition and another was found with the top broken off 6 inches below the surface of the ground, but the third one could not be found. The broken mark is 11.67 meters S. 10° 52′ E. (mag.) from the station, and the other is 11.73 meters N. 16° 20′ W. (mag.) from the station.

Weed Patch (Brown County, G. A. Fairfield, 1889).—On Weed Patch Hill, claimed by some, though incorrectly, to be the highest point of land in the State, about 3 miles south-southeast of Nashville. The station is in the northern part of the SW. ¼ SE. ¼ SE. ¼ sec. 32, T. 9 N., R. 3 E., in a peach orchard belonging to Rufus W. Reddick, just north of the road running east and west across the top of the hill. The station is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: 32.7 meters S. 37° 44′ E.; near the corner of a log barn, 37.8 meters S. 14° 00′ W.; and near an apple tree, 15.0 meters N. 7° 02′ W.

Fountain (Jackson County, G. A. Fairfield, 1887).—About 2½ miles from the town of Clear Springs, in the NW. ¼ sec. 24, T. 6 N., R. 2 E., on land belonging to Thomas Fountain, a short distance northwest of his house and barn. The station is in an open field near the edge of a beech woods. It is marked according to note 18.[1] The reference marks are at the edge of the woods at the following distances and magnetic bearings from the station: 26.88 meters S. 62° 36′ W., 22.89 meters N. 55° 04′ W., and 19.00 meters N. 18° 41′ E. A lone beech tree 6.7 meters southeast of the first reference mark bears S. 48° 16′ W. (mag.) from the station.

Rariden (Lawrence County, G. A. Fairfield, 1887).—About 3 miles from Mitchell, on the top of a hill on the farm of S. R. Rariden, about one-fourth mile west of his house. The hill is wooded except near the station. The station is in the northwest corner of sec. 27, T. 4 N., R. 1 W., and is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: 6.73 meters N. 0° 43′ W., 9.14 meters S. 89° 23′ E., and 8.26 meters N. 86° 56′ W. Three trees marked with spikes are at the following distances and magnetic bearings from the station: Oak, 14.5 meters N. 45° 43′ E.; poplar, 15.7 meters S. 26° 35′ E.; and oak with broken top, 20.6 meters S. 68° 04′ W.

Leonard (Monroe County, G. A. Fairfield, 1887).—About 7 miles southwest of Bloomington, on the crest of a hill on the south side of the Stamford road, in the NE. ¼ NW. ¼ sec. 26, T. 8 N., R. 2 W. The station is on the north edge of a young orchard belonging to Thomas Ragan just north of his house. It is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: 21.43 meters N. 83° 30′ W., 17.10 meters north, and 33.18 meters N. 78° 13′ E. The first and third marks are in the fence line on the south side of the Stamford road, and the second mark is near the fence line on the north side of the road. There is a stump just south of the first reference mark.

Beard (Lawrence County, G. A. Fairfield, 1887).—About 7 miles from Harrodsburg and 2½ miles from Springville, on a hill near the center of a cultivated field owned by J. T. Beard. The station is in Perry Township in the SE. ¼ sec. 10, T. 6 N., R. 2 W. It is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: 37.98 meters N. 17° 00′ E., 51.17 meters S. 42° 28′ E., and 71.14 meters S. 66° 28′ W. The second reference mark is in line with a mulberry tree about 125 meters from the station. A large oak is near the section line just east of the mulberry tree.

Calvary (Greene County, G. A. Fairfield, 1886).—In the extreme northwest corner of Center Township about 10 miles east of Worthington and about the same distance northeast of Bloomfield in the NE. ¼ NE. ¼ sec. 2, T. 7 N., R. 4 W., on the highest point of a high hill on land owned by Westley Gaston who lives about one-fourth mile northeast of the station. The station is marked according to note 18.[1] The reference marks are near the fence line on the north side of the road south of the station and are

[1] See pp. 27 and 28.

at the following distances and magnetic bearings from the station: On the line between sections 1 and 2, 209.5 meters S. 62° 18′ E.; in range with a large tree on the opposite side of the road, 107.7 meters S. 1° 20′ E.; and 143.3 meters S. 30° 30′ W.

Osborn (Martin County, G. A. Fairfield, 1886).—About 4 miles south and 1 mile east of Scotland, in the northwest corner of the SW. ¼ NE. ¼ sec. 20, T. 5 N., R. 4 W., on top of a hill on land owned by James Osborn. There is a road which makes a right-angled bend to the north a short distance southwest of the station and another right-angled bend to the east just northwest of the station. The home of H. T. Sumerville is on the west side of the north-and-south section of this road about 100 meters west of the station. The station is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: Near the fence east of the station, 30.5 meters N. 70° 30′ E.; near the corner of the field where the two fence lines intersect, 56.2 meters S. 43° 45′ E.; and near the fence line west of the station, 65.4 meters S. 23° 30′ W.

Sisson (Sullivan County, G. A. Fairfield, 1885).—About 2 miles from Pleasantville just south of the road to Carlisle and south of a small dwelling house occupied by James L. Anderson which is on the north side of the road. The station is in Jefferson Township in the SW. ¼ NE. ¼ sec. 10, T. 6 N., R. 8 W., on land belonging to Mr. Sisson, an old man living about three-fourths mile north of the station. The station is marked according to note 18.[1] The reference marks are at the following distances and magnetic bearings from the station: In the fence corner where the fence west of the station joins the road fence, 67.5 meters N. 76° 00′ W.; in the yard of Anderson's house, 52.7 meters N. 15° 05′ W.; and on the inside of the fence along the south side of the road, 61.8 meters N. 52° 51′ E. The second reference post is in line between the southeast corner of the house and the well, 4.85 meters from the house and 2.59 meters from the well.

Wright (Greene County, G. A. Fairfield, 1886).—In Wright Township near the center of sec. 21, T. 8 N., R. 7 W., on land owned by W. H. Smith whose house and barns are about 150 meters in a northwesterly direction from the station. The station is on the crest of the highest ground in the neighborhood and is marked according to note 18.[1] The reference marks are near the fence along the west side of the road east of the station at the following distances and magnetic bearings from the station: Just south of the driveway to Smith's house, 98.7 meters N. 47° 30′ E.; 77.7 meters N. 88° 30′ E.; and near the southeast corner of the quarter section, 137.6 meters S. 38° 30′ E.

Summit (Knox County, G. A. Fairfield, 1884).—About 2½ miles from Bruceville, on the northwest side of the road from that place opposite the point where the road to Bicknell branches to the southeast. The station is in Washington Township in plat 122 near the southern end of a large field owned by Peter Fox who lives southeast of the station on the southwest side of the Bicknell road. There is a schoolhouse at the junction of the two roads and its northwest corner is 91.4 meters S. 68° 30′ E. from the station. The station is marked according to note 18.[1] The reference marks are just inside the fence line on the north side of the Bruceville road at the following distances and magnetic bearings from the station: 79.74 meters S. 68° 30′ E., 49.28 meters S. 12° 52′ E., and 52.8 meters S. 42° W. There is a lone black walnut tree 27.4 meters N. 85° W. of the station and a similar tree on A. Green's land 71.6 meters N. 70° E. The northwest corner of a house in ruins on the opposite side of the road is 83.8 meters S. 47° W. from the station.

Merom College (Sullivan County, G. A. Fairfield, 1885).—The center of the spire on the cupola of Merom College. The station was marked on the inside of the cupola by a cross and a copper tack in the top of the center post of the spiral stairway leading from the attic to the cupola.

Honey Creek (Crawford County, Ill., G. A. Fairfield, 1884).—In Honey Creek Township, in an open field belonging to J. W. Love in the southwest corner of NE. ¼ NW. ¼ NE. ¼ sec. 35, T. 6 N., R. 12 W. The station is 157.6 meters south of the fence along the south side of the section-line road and is marked by cross in the top of a white marble post about 6 inches square and 30 inches long, projecting 4 to 6 inches above the ground. The letters U. S. C. & G. S. are inscribed in the face of the post. The underground mark is the apex of an earthenware pyramid about 6 inches on an edge and has on one face the raised letters U. S. C. S. There are three reference marks, which are white marble posts slightly smaller than the station mark with an arrow on the top pointing to the station. The posts are located as follows: In the fence line 157.6 meters north from the station, 214.2 meters west, and 264.7 meters N. 54° 15′ W. The northeast corner of the section mentioned above is 616.0 meters N. 74° 10′ E.

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[1] See pp. 27 and 28.

Belle Air (Clark County, Ill., G. A. Fairfield, 1884).—This station was established by the U. S. Engineers in 1879. It is in Orange Township in section 32, T. 9 N. R. 13 W., 23.5 meters north of the fence on the south side of the section-line road dividing Clark and Crawford Counties, and 66.9 meters N. 53° 17′ E. from the northeast corner of a house belonging to Isaac Hart. The station is marked according to note 16.[1] Three stone reference posts with the letters U. S. inscribed in the tops are located as follows: In the fence line on the south side of the road, 41.4 meters S. 38° 7′ W.; in the same fence line 56.6 meters S. 58° 8′ E.; and in the fence line on the north side of the road, 17.8 meters S. 49° 50′ E. The section corner between sections 4 and 5 is 559 meters S. 86° 28′ W.

Hunt City (Jasper County, Ill., G. A. Fairfield, 1884).—This station was established in 1879 by the U. S. Engineers. It is in Grandville Township, in the NE. ¼ NW. ¼ sec. 7, T. 7 N., R. 14 W., about 10 miles northeast of Newton and three-fourths mile northeast of Hunt City, a small station on the Danville, Olney & Ohio River Railroad. The station is marked according to note 16.[1] Three stone reference posts are located as follows: One on the east side of the section-line road west of the station, 678.88 meters S. 85° 32′ W., and two on the south side of the section-line road north of the station, one distant 334.71 meters N. 33° 52′ E., and the other distant 282.62 meters N. 9° 54′ W. The northwest corner of the section mentioned above is 749.0 meters N. 66° 46′ W.

Claremont (Richland County, Ill., G. A. Fairfield, 1884).—This station was established in 1879 by the U. S. Engineers. It is in German Township, in sec. 29 T. 4 N., R. 14 W., on land belonging to the Brinkley heirs, about 3 miles in a northwesterly direction from the town of Claremont. The station is marked according to note 16.[1] Three stone reference posts are located as follows: 23.1 meters N. 67° 33′ W., 7.8 meters N. 0° 39′ W., and 24.6 meters N. 71° 45′ E. The northwest corner of the section mentioned above is 847 meters N. 60° 03′ from the station.

SUPPLEMENTARY POINTS.

Vincennes Latitude and Longitude (Knox County, E. Smith, 1881).—In the courthouse yard at Vincennes, 55.58 meters east and 14.78 meters north of the cupola of the clock tower of the courthouse, about 6 meters from the iron fence along Broadway Street and about midway between Seventh and Eighth Streets. The station is marked by a cross in the top of a short stone post projecting 2 or 3 inches above the surface of the ground. On either side of this is a longer stone post projecting about 3 feet above the ground and used for supporting the instrument. The two high posts are inscribed as follows:. "U. S. Coast and Geodetic Survey, 1881."

PRECISE TRIANGULATION, THIRTY-NINTH PARALLEL TO LOUISVILLE, KY.

PRINCIPAL POINTS.

Blocher (Scott County, E. H. Pagenhart, 1914).—About three-fourths mile north-northeast of the town of Blocher, 250 meters east of the Baltimore & Ohio Southwestern Railroad, 120 meters northeast of a concrete culvert on the Deputy-Madison pike, and directly opposite the house of Mrs. Elizabeth J. Brinton, which is on the west side of the pike. The station is 70 meters east of the pike, on land belonging to D. R. Chasteen, who lives one-half mile southeast of the station, and is 5 meters south of Chasteen's north line fence. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] Both reference marks are in the fence line north of the station, one between two small cedars, about 20 meters apart, 100 meters east of the pike, and 32.08 meters from the station in azimuth 261° 31′. The other reference mark is 30 meters east of the pike and 34.62 meters from the station, in azimuth 99° 25′.

Finley (Scott County, E. H. Pagenhart, 1914).—About 9 miles southwest of Scottsburg and 2½ miles west-southwest of the Leota store, on the eastern edge of the flat-topped hills known locally as Finley Knobs, about three-fourths mile south of the Scottsburg-Salem road and one-fourth mile east of the Scott-Washington county line. The station is on the highest ground in the most northeasterly cultivated field on the hill, on land belonging to Mrs Sarah Wolfe, one-fourth mile northeast of her house. A spur begins 250 meters north of the station and extends in a northeasterly direction, ending in a knob three-fourths mile from the station. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] One reference mark is in a fence line 60 meters west of the

[1] See pp. 27 and 28.

timber line and 30.30 meters from the station, in azimuth 24° 00′. The other reference mark is on the timber line on the east brow of the hill, 3 meters lower than the station and 41.88 meters distant, in azimuth 271° 43′.

Summit (Clark County, J. B. Baylor, 1886; 1914).—On the Indiana State Forest Reservation, 2 miles west of the administration building of the reservation, 3 miles northwest of Henryville, and one-half mile south of the Henryville-Brownstown wagon road, on the top of a timbered knob known locally as Salaam Knob. The station is on the east slope of the top, about 1 meter below the highest point, and is marked according to note 19.[1] A lone pine tree 10 inches in diameter towers above the small trees which cover the top of the hill and is visible from Henryville. It stands on the highest point of the knob, 17.42 meters from the station, and is marked with a triangular blaze on the east side. The reference marks are at the following distances and directions from the station: 1.83 meters north (azimuth 193°), 1.86 meters east (azimuth 281°), and 1.84 meters south.

Marysville (Clark County, E. H. Pagenhart, 1914).—About one-half mile northwest of the depot at Marysville, 300 meters northwest of the schoolhouse, and 150 meters east of the house of George Harmon, on land belonging to Samuel W. Taflinger, of Jefferson, in an open field 8.1 meters from the fence on the southwest side of the Marysville-Lexington pike. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] The reference marks are in the fence line on the northeast side of the pike, one 25.77 meters from the station, in azimuth 280° 53′, and the other 33.13 meters, in azimuth 173° 54′.

O. & M. (Clark County, J. L. Campbell, 1884; 1914).—About 3 miles north of Charlestown, 4 miles south of Otisco, about 300 meters west of the Baltimore & Ohio Southwestern Railroad, and 50 meters west of the Charlestown-Lexington wagon road. The station is 150 meters north of schoolhouse No. 9 of Charlestown Township and 50 meters northwest of a large beech tree standing at the head of a ravine close to the road, on land belonging to Mrs. Magdalene Flinchbaugh. The ground to the westward slopes down to a narrowing ridge and to the northeastward spreads out into a flat field, the highest point of which is about 100 meters north of the station. The station is marked according to note 8,[1] with the exception of the reference marks, which are the same as described in note 19.[1] They are at the following distances and directions from the station: 1.75 meters north, 1.82 meters east, and 1.87 meters south.

Popp (Clark County, E. H. Pagenhart, 1914).—About three-fourths mile southwest of Bennettsville, a station on the Chicago, Indianapolis & Louisville Railway, and 2½ miles northwest of St. Joseph, on the top of a timbered hill known locally as Haystack Knob, on land belonging to George Popp, who lives three-eighths of a mile northeast. Rock has been quarried on the top of the hill, leaving it a nearly flat, rocky surface, with a rim of earth on the outer edge. The station is on the highest ledge of rock 3 meters from the northeast end and 1 meter from the east side of the rim. It is marked by bronze tablets set in concrete, as described in notes 1a and 8d.[1] The reference marks are stone posts 5 inches square and 2 feet long projecting 4 inches above the ground and marked in the top with a cross-lined arrow pointing toward the station. One reference mark is on the south rim at the brow of the hill, 8.56 meters from the station, in azimuth 42° 20′, and the other is on the rim on the west brow of the hill, 1 meter lower than the station and 12.24 meters distant, in azimuth 102° 10′. The station is about 2 meters east of the old station *Haystack*, which was established in 1884 and destroyed later by the quarrying.

Lutz (Clark County, J. L. Campbell, 1884; 1914).—About 2 miles south-southwest of Charlestown and one-half mile east of the Baltimore & Ohio Southwestern Railroad and the Louisville & Northern Electric Railway, 200 meters southeast of the Clark County poorhouse, 200 meters west of the farmhouse on the old Lutz farm now owned by John E. Long. The station is in the northwest corner of a field, 5.4 meters east of the west fence and 3.4 meters south of the north fence, 10 meters east of the pike, and 6 meters south of the road leading to the Long house. It is marked according to note 19.[1] The reference marks are at the following distances and directions from the station: 1.79 meters north, 1.81 meters east, and 1.86 meters south.

Six Mile (Floyd County, J. L. Campbell, 1884; 1914).—About 6 miles north of New Albany, 2 miles south of St. Joseph, and one-fourth mile west of Six Mile switch on the Chicago, Indianapolis & Louisville Railway, on land belonging to Peter Weber, about 250 meters east of the house of Jacob Eberly, and 100 meters east of his east line. The land near Eberly's house is about 90 feet higher than the station. The station is on the footpath leading up the timbered spur from Six Mile switch to the top of the "Knobs" and to Eberly's house. It is marked according to note 19.[1] The reference

[1] See pp. 27 and 28.

marks are at the following distances and directions from the station: 1.91 meters north, 1.83 meters east, and 1.85 meters south. The east reference mark is on the trail described above. The station is about 75 meters east of an old stone quarry.

Sims (Jefferson County, Ky., J. L. Campbell, 1884).—There is no description available for this station. It is probably marked according to note 19,[1] that is, the same as the other stations established in this locality by Prof. J. L. Campbell in 1884.

Bangs (Floyd County, G. A. Fairfield, 1879).—Near the State Street turnpike on land belonging to J. B. Bangs, a short distance northeast of his house on the point of the range of hills on which his house stands. The hill is wooded except that part immediately surrounding the station, which is clear of both trees and stumps. The station is marked according to note 18,[1] except that the tops of the stone posts are dressed to 4 inches square instead of 6. The reference marks are 1.83 meters from the station, north, east, and south (magnetic), respectively.

Blind Asylum (Jefferson County, Ky., G. A. Fairfield, 1879).—In the cupola on top of the dome of the Kentucky Institution for the Blind, on Franklin Avenue near Pope Street, Louisville. The station is marked by a copper nail in the top of the circular cover of the ventilator. As reference marks there are four copper nails in the balustrade of the cupola, so placed that the diagonal lines joining them intersect at the station. They are at the following distances and directions from the station: 1.231 meters north, 1.250 meters east, 1.301 meters south, and 1.280 meters west.

Williams (Harrison County, G. A. Fairfield, 1879).—On a hill near Bridgeport, on land belonging to Frank Williams, on the highest ground of a cultivated field south of his house. The station is in the SW. ¼ SE. ¼ sec. 12, T. 4 S., R. 5 E., and is marked according to note 18,[1] except that the tops of the stone posts are dressed to 4 inches square instead of 6, and that the underground mark is a copper nail in the stopper of a glass bottle filled with ashes. The reference marks are 1.83 meters from the station, north, east, and south (magnetic), respectively.

Cox (Jefferson County, Ky., G. A. Fairfield, 1879).—About 5 miles from Louisville, on the highest point of a prominent knob known as Cox's Knob, on land belonging to Ben Figgs. The station is about 30 meters back of an old sandstone quarry on the northern point of the knob, and is marked according to note 18,[1] except that the top surface of the stone has been destroyed by vandals. According to the chief engineer of Louisville in 1916, the only reference mark that remains is 1.83 meters north (magnetic) from the station.

Louisville North Base (Jefferson County, Ky., G. A. Fairfield, 1879).—In the outskirts of Louisville, three-fourths mile south of the southern boundary of the fairgrounds and 100 meters north of Bells Lane, known locally as Gravel Pit Lane. The station in on land owned by the Standard Oil Co., and 25 meters north of a barn. It is marked by a cross in the top of a copper bolt set in a drill hole in the top of a granite post 4 feet 10 inches long and about 10 or 12 inches square. The top of the post is dressed in the form of a pyramid, with the inscription "U. S. C. & G. S., N. Base 1879," cut in the south face, and projects 1½ feet above the ground. The underground mark is an earthenware pyramid with edges about 4 inches long and with the letters U. S. C. S. cut in the four faces, buried about 3½ feet below the surface of the ground. There are three reference marks, each consisting of a stone post 2½ feet long, dressed to 4 inches square at the top, marked with a cross and arrow head pointing toward the station, and located as follows: 1.83 meters north in prolongation of the base line; 1.83 meters east, at right angles to the base line; and 1.83 meters south in the line of the base. The chief engineer of the city of Louisville states that in 1916 the station monument appeared to tilt from the perpendicular and that none of the reference marks were visible, possibly having been covered by filling.

Louisville South Base (Jefferson County, Ky., G. A. Fairfield, 1879).—About 7 miles from Louisville, a short distance east of the Salt River turnpike, on the right of way of the Illinois Central Railroad adjoining the cultivated field of B. H. Herrick, just north of a farm road crossing. It is marked the same as Louisville north base described above, except that "S. Base" replaces "N. Base" in the inscription. One reference mark is set 1.83 meters north in the line of the base, and the other is 1.83 meters east, at right angles to the base. The chief engineer of the city of Louisville states that in 1916 the station was in good condition.

Riley (Jefferson County, Ky., G. A. Fairfield, 1879).—Near the Blue Lick pike, about 3½ miles from the Preston Street turnpike, on land belonging to W. H. Riley, on the only cleared knob of several knobs north of his house. The station is marked according to note 18,[1] except that the tops of the posts are dressed to 4 inches square instead of 6. The reference marks are 1.83 meters from the station north, east, and south, respectively.

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[1] See pp. 27 and 28.

Potts (Harrison County, C. S., 1880; 1882).—South-southwest of Bridgeport and southeast of Elizabeth, in the NW. ¼ SW. ¼ sec. 11, T. 5 S., R. 5 E., on land belonging to J. Potts. The station is marked by a granite post 2.8 feet long, dressed to 4 inches square at the top, and marked with a cross and the letters U. S. C. G. S. The underground mark is a glass bottle filled with ashes about 3.1 feet below the ground. Four hard-burned bricks, each marked with an arrow head pointing toward the station, are 2.3 feet below the ground and 2.5 feet from the station north, east, south, and west (magnetic), respectively. The station is surrounded by a concentric ring of charcoal 1 foot wide, 0.9 foot deep, and 8.4 feet in diameter, about 2 feet below the surface of the ground. The following distances and magnetic bearings are from the station: Chestnut tree, 28.7 meters N. 66° 50′ E.; nearest corner of barn, 53.2 meters S. 31° 12′ E.; nearest corner of dwelling, 39.7 meters; lightning rod on dwelling, N. 87° 09′ W.; nearest corner of small shed, 22.5 meters.

SUPPLEMENTARY POINTS.

Haystack (Clark County, J. L. Campbell, 1884, 1914).—Lost.

Bartle (Clark County, J. L. Campbell, 1886.)—There is no description available for this station. It is probably marked according to note 19,[1] that is, the same as the other stations established in this locality by Prof. J. L. Campbell.

PRECISE TRAVERSE, NORTH VERNON TO SOUTH BEND.

PRINCIPAL POINTS.

Adams (Jennings County, J. S. Bilby, 1920).—About 1 mile west of North Vernon, 400 yards west of a lamp-chimney factory, and 2 yards north of the Baltimore & Ohio Railroad right of way fence line, in a small field between the railroad and the highway, and 40 yards south of the highway. The north and nearest rail of the main track is 13.26 meters (43.50 feet) distant. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right-of-way fence line on the same side of the track as the station, 20.55 meters (67.42 feet) from the station in azimuth 82° 40′.

North Vernon (Jennings County, J. S. Bilby, 1920).—In the railroad yards of North Vernon, about 25 yards west of the round brick tower of the Baltimore & Ohio Railroad station, 3.38 meters (11.09 feet) north of the rail of the railroad siding, and about 25 yards east of Madison Street. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The north and nearest rail of the Baltimore & Ohio main line is at a distance of 7.940 meters (26.05 feet), and the east and nearest rail (the right going to Indianapolis) of the Pennsylvania main line is at a distance of 7.945 meters (26.07 feet). The reference mark is set in concrete in the curb at the south side of O and M Avenue, 15.11 meters (49.57 feet) from the station in azimuth 199° 26′.

Allen (Jennings County, J. S. Bilby, 1920).—About one-half mile north of North Vernon railway station, on the right of way of the Pennsylvania Railroad, and between the railroad and the highway, about 30 yards south of the main entrance to St. Mary's Cemetery, and about 120 yards south of a highway crossing, 6.39 meters (20.96 feet) west of the west and nearest rail of the main track (on the left going toward Indianapolis). The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is placed alongside the iron picket fence surrounding the cemetery, 14.583 meters (47.84 feet) from the station in azimuth 226° 58′.

Bartholomew (Jennings County, J. S. Bilby, 1920).—On the east side of the Pennsylvania Railroad right of way, about 2¼ miles north of North Vernon, about 235 yards south of culvert 199, and just at the north end of a fairly long cut. The east and nearest rail (the right going to Indianapolis) is distant 6.04 meters (19.80 feet). The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track and close to the right-of-way fence, 27.82 meters (91.27 feet) from the station in azimuth 103° 54′.

Benton (Jennings County, J. S. Bilby, 1920).—On the east side of the Pennsylvania Railroad right of way, 1 yard from the fence line, 3 miles north of North Vernon, and about 50 yards south of a farm road crossing, 6.650 meters (21.82 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is at the fence corner at the farm road crossing and on the opposite side of the track, 52.51 meters (172.27 feet) from the station in azimuth 119° 29′.

[1] See pp. 27 and 28.

Blackfork (Jennings County, J. S. Bilby, 1920).—About 5 miles north of North Vernon, three-fourths mile north of Queensville, about 280 yards south of milepost C 16, on the east side of the Pennsylvania Railroad right of way and 1 yard from the fence, about 115 yards south of a highway crossing, 4.31 meters (14.14 feet) from the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track in the fence line, 13.24 meters (43.44 feet) from the station in azimuth 18° 52′.

Boon (Jennings County, J. S. Bilby, 1920).—About 7½ miles north of North Vernon, 20 yards north of a highway crossing, on the east side of the Pennsylvania Railroad right of way, 4.4 meters (14.44 feet) from the fence line and 4.96 meters (16.27 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is at the near fence corner by the highway crossing on the same side of the track, 20.08 meters (65.88 feet) from the station in azimuth 300° 27′.

Brown (Bartholomew County, J. S. Bilby, 1920).—About one-half mile south of Elizabethtown on the east (the right going toward Indianapolis) side of the Pennsylvania Railroad and between it and the highway, opposite the fifth telegraph pole north of the crossing, and 465 yards south of milepost C9 the east and near rail is distant 4.70 meters (15.42 feet). The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is opposite, across the track and near the fence line, 15.62 meters (51.24 feet) from the station in azimuth 31° 12′.

Carroll (Bartholomew County, J. S. Bilby, 1920).—On the west (the left going toward Indianapolis) side of the Pennsylvania Railroad right of way, about 4½ miles south of Columbus, about 20 yards north of a former switch (siding still in place but the switch has been removed) and about 190 yards north of a highway crossing, 4.265 meters (14.0 feet) from the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, 11a.[1] The reference mark is on the same side of the track near the fence line and about 3 feet higher than the station mark, 20.05 meters (65.78 feet) from the station in azimuth 120° 36′.

Cass (Bartholomew County, J. S. Bilby, 1920).—About 3½ miles south of Columbus, on the east side of the Pennsylvania Railroad right of way, about 75 yards south of a farm road crossing, 1.6 meters (5.2 feet) from the right-of-way fence, 2.335 meters (7.66 feet) east of the east and near rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is close to the fence line and just off the right of way on the same side of the track as the station, 6.005 meters (19.70 feet) from the station in azimuth 151° 10′.

Columbus (Bartholomew County, J. S. Bilby, 1920).—In the city of Columbus, about 60 yards south of the Pennsylvania Railroad station, just inside the curb lines at the intersection of Jackson and Sixth Streets on the northwest corner, 18.935 meters (62.12 feet) from the west rail of the Pennsylvania Railroad, and between two sidings 3.50 meters (11.48 feet) south of one and 1.53 meters (5.02 feet) north of the other, the latter being the original location of the main line of the Pennsylvania Railroad. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the street and inside the walk, 31.32 meters (101.76 feet) from the station in azimuth 319° 31′.

Clay (Bartholomew County, J. S. Bilby, 1920).—In the northern part of Columbus, on land owned by Francis Overstreet, on a prolongation of the west curb line of Jackson Street, at a point where the street has no curb, and about 150 yards north of the point where the main line of the Pennsylvania Railroad leaves Jackson Street, and 16.475 meters (54.05 feet) east of the east and nearest rail of the main line. The station, underground and reference marks are bronze tablets set in concrete as described by notes 1a, 7a, and 11a.[1] The reference mark is just outside the concrete walk on the opposite side of the street, 10.46 meters (34.32 feet) from the station in azimuth 124° 43′.

Clark (Bartholomew County, J. S. Bilby, 1920).—About 1½ miles north of Columbus, and about 20 yards east of the main highway from Columbus to Franklin, and 4 yards south of the first roadway to the right after passing the covered bridge out of Columbus. This farm road leads to a small farmhouse across the Pennsylvania Railroad and the electric line. The station is 470 yards north of milepost I 40, at the point of intersection of the first curve after crossing the bridge going north from Columbus, and 16.620 meters (54.53 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described by notes 1a, 7a,

[1] See pp. 27 and 28.

and 11a.[1] The reference mark is on the right of way and close to the west fence, 9.315 meters (30.56 feet) from the station in azimuth 269° 16′.

Clinton (Bartholomew County, J. S. Bilby, 1920).—Seven miles north of Columbus, at McSweeny's Crossing, stop 46 of the electric railway, about 9 yards south of the road crossing, on the east side of the Pennsylvania Railroad right of way, 4.58 meters (15.03 feet) from the east and nearest rail, and between the railroad and the electric line, 8.015 meters (26.28 feet) west of the west and nearest rail of the electric line, and 80 yards south of milepost I 34. The station, underground, and reference marks are bronze tablets set in concrete as described by notes 1a, 7a, and 11a.[1] The reference mark is in the east right of way fence line, 5.473 meters (17.95 feet) from the station in azimuth 314° 41′.

Edinburg (Johnson County, J. S. Bilby, 1920).—In the town of Edinburg, just outside of the fence line on the west side of the Pennsylvania Railroad right of way, 18 yards south of the road crossing leading into the Amos Lumber Co. plant, which road is a continuation of Hendrick Street, 8.39 meters (27.53 feet) from the west and nearest rail of the Pennsylvania Railroad main-line track. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] The reference mark is on the fence corner on the same side of the track as the station, 23.975 meters (78.66 feet) from the station in azimuth 343° 24′.

Crawford (Johnson County, J. S. Bilby, 1920).—At the northern edge of Edinburg, 4.655 meters (15.27 feet) east of the east and nearest rail of the main line of the Pennsylvania Railroad and east of the northern part of the yards of the Union Starch & Refining Co., about 130 yards south of milepost I 30, and about 100 yards north of a pumping station. The station is at the lower edge of a fill and will be covered if the fill is extended. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the fence line west of the station and across three sidings, 16.890 meters (55.41 feet) from the station in azimuth 222° 21′.

Daviess (Johnson County, J. S. Bilby, 1920).—About 2 miles north of Edinburg, on the east side of the Pennsylvania Railroad right of way, 6.000 meters (19.69 feet) from the east and nearest rail, about 70 yards north of Durham road crossing, which is stop 40 on the electric line, and about 560 yards south of milepost I 28. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right of way fence line on the same side of track as the station, 15.835 meters (51.95 feet) from the station in azimuth 332° 05′.

Dearborn (Johnson County, J. S. Bilby, 1920).—About 3½ miles north of Edinburg on the east side of the Pennsylvania Railroad right of way, 2.750 meters (9.02 feet) from the east and nearest rail, 65 yards north of milepost I 27, and about opposite the point where the interurban line ceases to parallel the railroad and curves to the westward. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right of way fence line on the same side of the track as the station, 5.655 meters (18.55 feet) from the station in azimuth 270° 04′.

Decature (Johnson County, J. S. Bilby, 1920).—About 7 miles north of Edinburg on the west side of the Pennsylvania Railroad, 5.875 meters (19.27 feet) west of the west and nearest rail, about 255 yards north of milepost I 24, and about 140 yards north of the point where the road, which passes a frame schoolhouse and interurban stop No. 36, crosses the railroad, on a knoll between the railroad and the electric line and 6.815 meters (22.36 feet) east of the east rail of the electric track. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the fence line on the opposite side of the railroad from the station, 13.870 meters (45.50 feet) from the station in azimuth 242° 33′.

Decalb (Johnson County, J. S. Bilby, 1920).—About 2 miles south of Franklin, on the east side of the Pennsylvania Railroad right of way, 3.255 meters (10.68 feet) from the east and nearest rail, about 315 yards north of milepost I 23, opposite stop 34 of the interurban line, 8 yards north of a road crossing. This road passes a brick schoolhouse farther west. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the right of way and of the road, and close to the fence line between the railroad and the interurban, 18.860 meters (61.88 feet) from the station in azimuth 12° 52′.

Delaware (Johnson County, J. S. Bilby, 1920).—About halfway between mileposts I 22 and I 23, on the east side of the Pennsylvania Railroad right of way, 4.970

[1] See pp. 27 and 28.

meters (16.31 feet) east of the east and nearest rail. The station can be reached by truck by turning in at a brick farmhouse and following the farm road about 50 yards east and north of the house. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track across the farm road and in the fence line, 13.82 meters (45.34 feet) from the station in azimuth 136° 42′.

Dubois (Johnson County, J. S. Bilby, 1920).—In the town of Franklin, on the west side of the Pennsylvania Railroad, 12.59 meters (41.31 feet) from the west and nearest rail, 20 yards west of the point where Madison highway crosses the railroad, and between the railroad and the interurban line, 6.90 meters (22.64 feet) from the east rail of the interurban, and 3 yards south of the interurban section house No. 3. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the railroad and near the street, 19.44 meters (63.78 feet) from the station in azimuth 216° 19′.

Franklin (Johnson County, J. S. Bilby, 1920).—In the town of Franklin, about 38 yards south of the south corner of the Pennsylvania Railroad station, 1 meter (3.28 feet) east of the sidewalk on the east side of Railroad Street, about halfway between Jefferson and Monroe Streets, 14.035 meters (46.05 feet) west of the west and nearest rail of the railroad. The station and underground marks are bronze tablets set in concrete as described in notes, 1a and 7a.[1] There is no reference mark.

Elkhart (Johnson County, J. S. Bilby, 1920).—On the east side of the Pennsylvania Railroad right of way, about 1 mile north of Franklin, 2.480 meters (8.14 feet) east of the east and nearest rail, about 160 yards south of milepost I 19 and about 100 yards north of the north point of a siding. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track as the station and near the fence line, 8.435 meters (27.67 feet) from the station in azimuth 325° 35′.

Whiteland (Johnson County, J. S. Bilby, 1920).—About one-half mile south of Whiteland, on the west side of the Pennsylvania Railroad right of way, 7.43 meters (24.38 feet) from the west and nearest rail, and 9 yards south of milepost I 16 and on the opposite side of the track from it, about 80 yards south of WD tower, about 25 yards south of the south point of a siding, about 6 yards north of a farm road crossing, and about 1 yard from the fence line. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the fence line on the same side of the track, 4.25 meters (13.94 feet) from the station in azimuth 159° 34′.

Fayette (Johnson County, J. S. Bilby, 1920).—About 1½ miles north of Whiteland, on the east side of the Pennsylvania Railroad right of way, 3.855 meters (12.65 feet) from the east and nearest rail, about one-fourth mile south of milepost I 14 and about 290 yards north of the road crossing. This road goes east from stop 22 on the interurban. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the fence line on the same side of the track as the station, 7.872 meters (25.83 feet) from the station in azimuth 172° 11′.

Floyd (Johnson County, J. S. Bilby, 1920).—On the west side of the Pennsylvania Railroad right of way, 5.930 meters (19.46 feet) from the west and nearest rail, about one-half mile south of Greenwood on the southern end of a cut, about one-half mile north of milepost I 12, directly opposite the dairy barn on the Polk farm, and about 7 yards from the western right-of-way fence line. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is 14.722 meters (48.30 feet) from the station in azimuth 131° 31′.

Greenwood (Johnson County, J. S. Bilby, 1920).—On the Pennsylvania Railroad right of way, 2.230 meters (7.32 feet) east of the east and nearest rail, about one-half mile north of Greenwood, about 20 yards south of the point where Northwest Street crosses the railroad, and 75 yards north of the northern end of the western Greenwood siding. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track as the station and in the acute angle at the junction of the highway and right-of-way fences, 28.59 meters (93.80 feet) from the station in azimuth 170° 59′.

Fountain (Marion County, J. S. Bilby, 1920).—On the west side of the Pennsylvania Railroad right of way, 5.390 meters (17.68 feet) from the west and nearest rail, about 3 miles north of Greenwood, on top of a cut and about 540 yards south of the road crossing going east from interurban station No. 11. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

[1] See pp. 27 and 28.

Fulton (Marion County, J. S. Bilby, 1920).—About 6 miles south of Indianapolis, on the east side of the Pennsylvania Railroad right of way, 10.975 meters (36.01 feet) from the east and nearest rail, about 200 yards south of milepost I 6 and about 10 yards south of where Edgewood Avenue crosses the railroad. Edgewood Avenue is the street going east from interurban stop No. 8. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the fence line on the same side of the track as the station, 2.350 meters (7.71 feet) from the station in azimuth 276° 44′.

Traction (Marion County, J. S. Bilby, 1920).—On Shelby Street, where the Pennsylvania Railroad crosses that street and the interurban, about 4 miles south of the center of Indianapolis, 5.115 meters (16.78 feet) west of the west and nearest rail of the Pennsylvania Railroad, and 1.610 meters (5.28 feet) east of the east and nearest rail of the interurban, about 235 yards north of Pennsylvania Railroad milepost I 4. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is across the Pennsylvania Railroad track and near the east right-of-way fence, 14.76 meters (48.43 feet) from the station in azimuth 258° 22′.

Shelby (Marion County, J. S. Bilby, 1920).—About 280 yards south of Indianapolis city limits, in Shelby Street, 1.230 meters (4.04 feet) east of the east rail of the Interstate Public Service Co. electric line and about 1.3 meters (4.3 feet) south of the prolongation of the line of the northern side of Mr. Burkhart's brick house, which is on the opposite side of the street. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the street from the station and just inside the walk line, 28.315 meters (92.90 feet) from the station in azimuth 30° 39′.

Troy (Marion County, J. S. Bilby, 1920).—In the city of Indianapolis, at the intersection of Shelby and Troy Streets, in the concrete street on the projection of the curb line of Shelby Street, 4.950 meters (16.24 feet) from the east rail of the street car track, and 2.780 meters (9.12 feet) from the curb on the south side of Troy Street. The station is marked by a bronze tablet set in the concrete pavement. A standard bronze reference tablet is set in the concrete curb on the east side of Shelby Street, 13.61 meters (44.65 feet) from the station in azimuth 179° 18′.

Kerk (Marion County, J. S. Bilby, 1920).—On the north side of Troy Street, 0.1 meter (0.33 foot) from the edge of the concrete road, and 0.7 meter (2.30 feet) east of the prolongation of the east fence line of the H. Kerkhoff property, about one-eighth mile east of Keystone Avenue, and seven-eighths mile west of Sherman Drive. The station is marked by a standard bronze tablet set in the concrete road. The reference mark, a bronze tablet set in concrete as described in note 11a,[1] is just east of the fence line mentioned above, 5.255 meters (17.14 feet) from the station in azimuth 179° 07′.

Sherman (Marion County, J. S. Bilby, 1920).—At the northeast corner of the intersection of Troy Street and Sherman Drive, 4.03 meters (13.22 feet) from the southeast corner of the sidewalk. The station is marked by a bronze tablet set in the concrete road. The reference mark is a bronze tablet set in concrete as described in note 11a.[1] The reference mark is 0.3 meter (0.98 foot) north of the sidewalk on Troy Street, 9.475 meters (31.09 feet) from the station in azimuth 287° 28′. The center of a manhole is 18.315 meters (60.09 feet) from the station in azimuth 141° 32′, and the top of a fire plug is 6.50 meters (21.33 feet) from it in azimuth 353° 21′.

Elevator (Marion County, J. S. Bilby, 1920).—In the city of Indianapolis, on the west side of Sherman Drive, 0.425 meter (1.39 feet) inside the edge of the concrete road, and opposite a large concrete grain elevator, 125 yards south of the Big Four crossing, and about 10 feet south of the southern boundary of the E. E. Hamilton property. The station is marked by a bronze tablet set in the concrete road. The reference mark, a bronze tablet set in concrete as described in note 11a,[1] is set in the fence line on the opposite side of the road, 9.575 meters (31.41 feet) from the station in azimuth 273° 47′.

Prospect (Marion County, J. S. Bilby, 1920).—In the city of Indianapolis, on Sherman Drive near Prospect Street 0.365 meter (1.20 feet) inside the edge of the concrete roadway, 16.395 meters (53.79 feet) south of the south and nearest rail of the electric line on Prospect Street. The station is marked by a bronze tablet set in the concrete road. The reference mark, a bronze tablet set in concrete as described in note 11a,[1] is on the north side of Prospect Street close to the fence line, distant 30.83 meters (101.15 feet) in azimuth 153° 39′.

Michigan (Marion County, J. S. Bilby, 1920).—In the city of Indianapolis, on the south side of Prospect Street, on the concrete curb at the south edge of the asphalt paving, 14.705 meters(48.24 feet) south of the south and nearest rail of the electric line

[1] See pp. 27 and 28.

which parallels the street on the north, and 6.67 meters (21.88 feet) from the inner corner of a concrete culvert at the intersection of Michigan Avenue and Prospect Street. The station is marked by a standard disk station mark set in the concrete curb above mentioned. The reference mark is a bronze tablet set in concrete as described in note 11a,[1] and is located in the triangular lot between Michigan Avenue and Prospect Street, 14.805 meters (48.57 feet) from the station in azimuth 309° 30′.

Emerson (Marion County, J. S. Bilby, 1920).—At the corner of Prospect Avenue and South Emerson Avenue, 1.45 meters (4.76 feet) south from the south edge of the concrete road on Prospect Avenue, and 6.8 meters (22.3 feet) west from the west side of the concrete paving of South Emerson Avenue, 14.425 meters (47.33 feet) south of the south and nearest rail of the Indianapolis & Cincinnati Traction Co. track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] The reference mark is a standard disk reference mark set in the west end of a concrete culvert 3.865 meters (12.68 feet) from the station in azimuth 280° 02′.

Subway (Marion County, J. S. Bilby, 1920).—On the east side of the concrete road known as South Emerson Avenue, 0.345 meter (1.13 feet) inside the east edge of the concrete paving, 60 yards north of the intersection of South Emerson Avenue and Fletcher Avenue. The station is marked by a standard disk station mark set in the concrete paving. The reference mark is a bronze tablet set in concrete as described in note 11a,[1] and is located on the west side of the road, 13.475 meters (44.21 feet) from the station in azimuth 74° 16′.

Thoaman (Marion County, J. S. Bilby, 1920).—About 330 yards north of Tenth Street, on the east side of North Emerson Avenue, 0.610 meter (2.0 feet) inside the east edge of the concrete paving, and 15 meters (50 feet) north of the prolongation of the line of the north side of N. D. Broenhof's house, which is on the east side of the road. The station is marked by a standard disk station mark set in the concrete road. The reference mark is a bronze tablet set in concrete as described in note 11a.[1] The reference mark is on the west side of the street in the corner of a garden, 10.96 meters (35.96 feet) from the station in azimuth 98° 56′.

Pendleton (Marion County, J. S. Bilby, 1920).—About 300 yards north of the Pendleton Pike on the east side of North Emerson Avenue, 1.4 meters (4.59 feet) east of the east edge of the concrete paving of North Emerson Avenue, about 15 yards south of the private drive to the Dockweller Agriculture Chemical Co., and about 130 yards west of the west end of the same company's building, and about 65 yards south of the chemical company's office. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is 6.81 meters (22.34 feet) from the station in azimuth 211° 10′.

Avenue (Marion County, J. S. Bilby, 1920).—In the suburbs of Indianapolis, on the north side of Thirty-eighth Street at the intersection of North Emerson Avenue, 9.02 meters (29.59 feet) south of the south and nearest rail of the traction line, 4.1 meters (13.45 feet) southeast of the edge of the concrete road, and 5.07 meters (16.63 feet) southwest of the edge of the concrete road, and 10 meters southwest of the North Emerson Avenue traction station. The station is marked with a standard disk station mark set in the concrete road. The reference mark is a bronze tablet set in concrete as described in note 11a,[1] and is on the north side of the traction line track, 20.3 meters (66.6 feet) from the station in azimuth 156° 49′.

Brightwood (Marion County, J. S. Bilby, 1920).—About 1½ miles west of North Emerson Avenue on the south edge of Thirty-eighth Street, 0.10 meter (0.33 foot) north of the south edge of the concrete paving, 14.62 meters (47.96 feet) south of the south and nearest rail of the traction line, and about 80 yards east of a traction stop. The station is marked by a standard disk station mark set in the concrete road. The reference mark is a bronze tablet set in concrete as described in note 11a,[1] 9.90 meters (32.48 feet) from the station in azimuth 63° 32′.

Keystone (Marion County, J. S. Bilby, 1920).—At the intersection of Thirty-eighth Street and Keystone Avenue, 0.135 meter (0.44 foot) inside the west edge of the concrete paving on Keystone Avenue, 21.950 meters (72.02 feet) south of the south and nearest rail of the traction line, 0.88 meter (2.89 feet) east of the east edge of the culvert, and 18 meters (59 feet) northwest of the northwest corner of the Keystone Grocery and Meats building. The station is marked by a bronze tablet set in the concrete paving. The reference mark is a bronze tablet set in concrete, as described in note 11a,[1] on the west side of Keystone Avenue, 5.52 meters (18.11 feet) from the station in azimuth 38° 17′.

Lake (Marion County, J. S. Bilby, 1920).—About three-fourths mile north of Thirty-eighth Street on the east edge of Keystone Avenue, about 25 yards south of the south side of Neatherford's yard, 1.3 meters (4.3 feet) west of the fence along the

[1] See pp. 27 and 28.

road, and about 300 yards north of the covered bridge over Fall Creek. The Indianapolis City Water Supply pumping station is just west of this bridge. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is 27.00 meters (88.58 feet) from the station in azimuth 152° 54′.

Erie (Marion County, J. S. Bilby, 1920).—On the east side of the extension of Keystone Avenue about 90 yards north of the point where the Lake Erie & Western Railroad crosses said road, and about 80 yards south of the drive leading into A. W Bright's barnyard, 24.945 meters (81.84 feet) northwest of the north and nearest rail. The station is marked with a 2 by 4 stake driven into the ground with a cross mark on the head of a nail driven into it. The reference mark is a bronze tablet set in concrete as described in note 11a,[1] 19.95 meters (65.45 feet) from the station in azimuth 288° 09′.

Western (Marion County, J. S. Bilby, 1920).—In a cultivated field near a curve, and west of the Lake Erie & Western Railroad right of way, 60 yards south of a signal or telephone box on the right of way, and 18.312 meters (60.10 feet) west of the west rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right-of-way fence line, 12.403 meters (40.69 feet) from the station in azimuth 279° 52′.

Gibson (Marion County, J. S. Bilby, 1920).—On the west side of the Lake Erie & Western Railroad right of way, 5.00 meters (16.40 feet) from the west and nearest rail, about 200 yards north of semaphore M8–1, 1 yard east of the fence line, and about 110 yards south of the G. M. Hunt farm road crossing. The station, underground, and reference marks are bronze tablets set in concrete and described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track in the fence line, 15.22, meters (49.93 feet) from the station in azimuth 287° 34′.

Grant (Marion County, J. S. Bilby, 1920).—On the east side of the Lake Erie & Western Railroad right of way, 2.70 meters (8.86 feet) from the east and nearest rail about 480 yards south of a road crossing, about 300 yards south of semaphore M9–1. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the east right-of-way fence line, 11.289 meters (37.04 feet) from the station in azimuth 3° 39′.

Green (Marion County, J. S. Bilby, 1920).—On the west side of a highway about 2 miles south of Castleton, near a point of intersection of two tangents of the Lake Erie & Western Railroad, 15.790 meters (51.80 feet) east of the east and nearest rail, 2 yards east of the west highway fence, and about 27 yards south of the crossing. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on private property in an acute angle between the highway and right-of-way fences, 8.53 meters (27.99 feet) from the station in azimuth 162° 32′.

Castleton (Hamilton County, J. S. Bilby, 1920).—On the east side of the Lake Erie & Western right of way, 4.85 meters (15.91 feet) from the east and nearest rail, 2 miles south of the railroad station Fisher, about 160 yards from the highway, and about 12 yards north of the farm road crossing going to the residence of Mr. Beaver. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a[1]. The reference mark is in the right-of-way fence line south of this road, 12.05 meters (39.53 feet) from the station in azimuth 21° 41′.

Fisher (Hamilton County, J. S. Bilby, 1920).—On the west side of the Lake Erie & Western Railroad right of way, 1.915 meters (6.25 feet) from the west and nearest rail, about one-third mile north of Fisher railroad station, and about 160 yards north of the first road crossing north of Fisher railroad station. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track in the fence line, 12.05 meters (39.53 feet) from the station in azimuth 264° 28′.

Frazier (Hamilton County, J. S. Bilby, 1920).—On the east side of the Lake Erie & Western Railroad right of way, 2.95 meters (9.68 feet) east of the east and nearest rail, about three-fourths of a mile north of Fisher railroad station and at the north end of a curve, and about 185 yards north of a highway crossing, the second north of Fisher railroad station. The reference, station, and underground marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right of-way fence on the opposite side of the track, 13.60 meters (44.62 feet) from the station in azimuth 133° 45′.

Hamilton (Hamilton County, J. S. Bilby, 1920).—About 3½ miles south of Noblesville on the east side of the Lake Erie & Western Railroad right of way, about 125 yards north of a road crossing, 2.175 meters (7.14 feet) east of the east and nearest rail.

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[1] See pp. 27 and 28.

The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track and near the right-of-way fence, 5.732 meters (18.81 feet) from the station in azimuth 295° 45′.

Hancock (Hamilton County, J. S. Bilby, 1920).—About 3 miles south of Noblesville on the west side of the Lake Erie & Western Railroad right of way, 8 yards north of a road crossing, and 5.86 meters (19.23 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track and near the right-of-way fence line, 8.305 meters (27.25 feet) from the station in azimuth 140° 30′.

Harrison (Hamilton County, J. S. Bilby, 1920).—About 1¼ miles south of Noblesville on the east side of the Lake Erie & Western Railroad right of way, about 330 yards north of semaphore signal M 20, about 245 yards southeast of a large concrete house with red tile roof. The station, underground, and reference marks are bronze tablets set in concrete and described in notes 1a, 7a, and 11a.[1] The reference mark is on the west side of the track and near the right-of-way fence, 7.15 meters (23.46 feet) from the station in azimuth 119° 01′.

Stake (Hamilton County, J. S. Bilby, 1920).—About 1¼ miles south of Noblesville, on the east side of the Lake Erie & Western Railroad right of way, 2.96 meters (9.71 feet) from the east and nearest rail, about 270 yards south of bridge No. 1245½, and at the second curve south of Noblesville. The station is marked by a nail in the top of a 2 by 4 inch stake driven into the ground. The reference mark is a nail in the top of a 2 by 4 inch stake on the east side of the track and 9.920 meters (32.55 feet) distant from the station in azimuth 177° 33′.

Stub (Hamilton County, J. S. Bilby, 1920).—About three-fourths mile south of Noblesville on the west side of the Lake Erie & Western Railroad right of way, about 320 yards south of the traction line bridge over the railroad, and about 75 yards north of the railroad bridge over a small creek, on a fill on the first curve south of Noblesville, 2.090 meters (6.86 feet) west of the west and nearest rail. The station is marked with a nail in the top of a 2 by 4 inch stake driven into the ground. There is no reference mark.

Sub (Hamilton County, J. S. Bilby, 1920).—The station is on the west side of the Lake Erie & Western Railroad right of way, one-half mile south of Noblesville, 2.295 meters (7.53 feet) west of the west and nearest rail, 275 yards south of the semaphore signal No. M 21 and the overhead interurban crossing. The station is marked by a nail in the top of a 2 by 4 inch stake driven into the ground, and the reference mark is the same as the station mark and is in the west right of way fence line, 9.138 meters (29.98 feet) from the station in azimuth 67° 44′.

Fill (Hamilton County, J. S. Bilby, 1920).—About three-fourths mile south of Noblesville on a high fill of the traction line, about 250 yards southwest of a bridge over the highway and the Lake Erie & Western track, on the south side of the traction line, 1.835 meters (6.02 feet) from the south and nearest rail. The station is marked by a nail in the top of a 2 by 4 inch stake. There is no reference mark.

Hendricks (Hamilton County, J. S. Bilby, 1920).—About one-half mile north of Noblesville on the west side of the Lake Erie & Western Railroad right of way, 15 yards south of semaphore signal No. M 23, on an extension of the west rail of the northern tangent, 9.180 meters (30.12 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the right of way fence line, 10.055 meters (32.99 feet) from the station in azimuth 351° 17′.

Brays (Hamilton County, J. S. Bilby, 1920).—On the west side of the Lake Erie & Western Railroad right of way, about 3 miles north of Noblesville, 2.690 meters (8.83 feet) west of the west and nearest rail and just west of a highway crossing, this being the road going west from Brays stop on the interurban. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is in the right of way fence line on the opposite side of the track, 13.540 meters (44.42 feet) from the station in azimuth 238° 41′.

Fox (Hamilton County, J. S. Bilby, 1920).—On the west side of Lake Erie & Western Railroad, about 2½ miles north of Noblesville, at the first curve south of wagon road crossing of the road leading west from the traction station of Fox Prairie, 1 foot west of the intersection of the tangents formed by the west rails 1.96 meters (6.43 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference

[1] See pp. 27 and 28.

mark is on the right of way near fence line, 12.19 meters (39.99 feet) from the station in azimuth 277° 24′.

Prairie (Hamilton County, J. S. Bilby, 1920).—About 2½ miles south of Cicero, on the west side of the Lake Erie & Western Railroad track, about 10 telegraph poles north of semaphore signal M 25, which is near where the Lake Erie & Western Railroad is crossed by the wagon road, leading west from Fox Prairie station on the nearby traction line. The residence of Henry Heinzman is about 80 yards southeast of the station and the west rail is 3.67 meters (12.04 feet) distant from the station. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the west side of the right of way, 3.06 meters (10.04 feet) from the station in azimuth 90° 13′.

Henry (Hamilton County, J. S. Bilby, 1920).—About one-fourth mile south of Cicero, on east side of Lake Erie & Western Railroad, 14 telegraph poles north of semaphore signal M 27. The residence of Mr. Sealy is 30 yards east of the station. The station is 4.165 meters (13.66) feet east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is north of the station, on the east side of the track, 8.67 meters (28.44 feet) from the station in azimuth 197° 44′.

Cicero (Hamilton County, J. S. Bilby, 1920).—About one-eighth mile north of Cicero railroad station, on the east side of the Lake Erie & Western Railroad, about 100 yards north of Cass Street, 20 yards south of switch signal to siding, 20 yards west of Kokomo highway, 3.260 meters (10.7 feet) east of the east and nearest rail of the main track. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is near the fence line on the west side of the track, 13.175 meters (43.23 feet) from the station in azimuth 102° 36′.

Tucker (Hamilton County, J. S. Bilby, 1920).—About one-half mile north of Cicero on east side of the track, 100 yards west of Kokomo highway, just back of Mr. Tucker's barn, 58.370 meters (191.50 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete and described in notes 1a, 7a, and 11a.[1] The reference mark is northeast of the station, 20.695 meters (67.90 feet) distant, in azimuth 213° 27′.

Howard (Hamilton County, J. S. Bilby, 1920).—About three-fourths mile north of Cicero, on east side of Lake Erie & Western Railroad, on second curve north of Cicero, six telegraph poles north of semaphore signal M 29, two telegraph poles south of whistle-board for crossing, 8.220 meters (26.97 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is near the fence on same side of the track, 10.450 meters (34.28 feet) from the station in azimuth 341° 33′.

Kinders (Hamilton County, J. S. Bilby, 1920).—About 1 mile south of Arcadia, on west side of Lake Erie & Western Railroad, 8 telegraph poles south of a road crossing, said crossing being about two-thirds mile south of Arcadia, on road passing interurban station at Kinders, 10 telegraph poles north of semaphore signal M 30, 2.310 meters (7.58 feet) from the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the east side of the track near the telegraph line, 15.410 meters (50.56 feet) from the station in azimuth 301° 52′.

Arcada (Hamilton County, J. S. Bilby, 1920).—About three-fourths mile north of Arcadia on the west side of Lake Erie & Western Railroad, about 100 yards north of the first road crossing north of the Arcadia city limits, about 130 yards south of semaphore signal M 32, 30 yards northeast of the John Flanigan homestead, 2.220 meters (7.28 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track near fence line, 9.26 meters (30.38 feet) from the station in azimuth 259° 53′.

Cox (Tipton County, J. S. Bilby, 1920).—About 1½ miles north of Atlanta, on east side of Lake Erie & Western Railroad, 30 yards southeast of the interurban station Cox, 10 yards south of the road crossing that crosses the electric line just south of interurban station Cox, one-half mile north of semaphore signal M 36, about 50 yards west of George Cox's residence, and 2.265 meters (7.43 feet) from east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] Reference mark is on opposite side of track, 12.41 meters (40.72 feet) from the station in azimuth 67° 59′.

Jay (Tipton County, J. S. Bilby, 1920).—About 1 mile south of Tipton, on the east side of track, about a mile north of Newkirk interurban station, 7 yards south of the

[1] See pp. 27 and 28.

semaphore signal M 38, about 80 yards southeast of passing track on the interurban, 2.200 meters (7.22 feet) east of east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 6.51 meters (21.36 feet) from the station in azimuth 262° 28′.

Jasper (Tipton County, J. S. Bilby, 1920).—About one-half mile south of Tipton, 150 yards north of the road crossing, southwest of the brick kiln, about 200 yards south of the railroad bridge No. 12–88, 5.635 meters (18.49 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.395 meters (37.38 feet) from the station in azimuth 327° 12′.

Tipton (Tipton County, J. S. Bilby, 1920).—The station is one-half mile south of Lake Erie & Western Railroad station at Tipton, two blocks east of Main Street, between Washington and Jefferson Streets, 2 yards east of the old freight depot, about 65 yards north of semaphore signal M 39, 2.735 meters (8.97 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of track, 11.05 meters (36.43 feet) from the station in azimuth 246° 34′.

Ressler (Tipton County, J. S. Bilby, 1920).—About 1⅓ miles north of Tipton, about 130 yards north of semaphore signal M 40, on east side of track, 15 yards north of the road which crosses the railroad track and electric line at Ressler interurban station, about 65 yards northeast of William Ressler's residence, 2.145 meters (7.04 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 13.03 meters (42.75 feet) from the station in azimuth 297° 59′.

Jackson (Tipton County, J. S. Bilby, 1920).—The station is 3 miles north of Tipton, on the west side of the track, about 220 yards north of Jackson elevator, about 130 yards north of a road crossing, which leads to Jackson interurban station, 30 yards southwest of W. H. Ansbury's residence, 7.115 meters (23.34 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] Reference mark is on the opposite side of the track, 18.11 meters (59.42 feet) from the station in azimuth 285° 57′.

New Hope (Tipton County, J. S. Bilby, 1920).—About 1⅓ miles south of Sharpsville, on the west side of the track, about 80 yards north of New Hope interurban station, 50 yards northeast of J. A. Youngman's residence, 6 yards east of the north and south highway, 5.550 meters (18.20 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 37.08 meters (121.65 feet) from the station in azimuth 178° 14′.

Midway (Tipton County, J. S. Bilby, 1920).—About 1 mile south of Sharpsville, on the west side of the track, about 325 yards north of road crossing the electric and railroad lines, about 100 yards south of John Linder's residence, 220 yards north of mileposts I 45 and M 114. The station is marked by a 2 by 4 inch stake with nail in top and is 4.340 meters (14.24 feet) west of the west and nearest rail. There is no reference mark.

Sharp (Tipton County, J. S. Bilby, 1920).—Station is about one-half mile north of Sharpsville, on east side of the track, 25 yards north of a road crossing, about 80 yards south of a canning factory, 15 yards northeast of a switch leading into the canning factory, 2.450 meters (8.0 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 24.83 meters (81.46 feet) from the station in azimuth 171° 21′.

Jefferson (Tipton County, J. S. Bilby, 1920).—About 1½ miles north of Sharpsville, on west side of track, 200 yards north of Howard interurban station, on the extension of the south tangent of first curve north of Sharpsville, 4.825 meters (15.83 feet) west of west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track across the electric track, 18.91 meters (62.04 feet) from the station in azimuth 87° 18′.

Duncan (Howard County, J. S. Bilby, 1920).—About 1 mile north of Fairfield, on east side of the track, about 65 yards north of milepost I 50 and M 108, about 325 yards south of road which crosses railroad and electric track at Duncan interurban station, 3.355 meters (11.0 feet) east of east and nearest rail. The station, underground,

[1] See pp. 27 and 28.

and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is 8.10 meters (26.57 feet) from the station in azimuth 187° 49′.

Jennings (Howard County, J. S. Bilby, 1920).—About one-fourth mile south of city limits of Kokomo, on east side of the track, about 40 yards south of mileposts M 107 and I 51, 150 yards northeast of large brick house, about 150 yards north of yard-limit sign, 7.290 meters (23.92 feet) east of east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.22 meters (36.81 feet) from the station in azimuth 341° 28′.

Main (Howard County, J. S. Bilby, 1920).—Station is on southeastern edge of Kokomo, northwest of intersection of Main and Maryland Streets, on west side of the track, 3 feet east of a fish market, 40 yards northwest of South Kokomo Bank, 12.150 meters (39.86 feet) west of west and nearest rail, 9.655 meters (31.68 feet) north of nearest traction rail. The station mark is a bronze tablet set in the concrete driveway alongside the fish market. There is no reference mark.

Buckeye (Howard County, J. S. Bilby, 1920).—About three-fourths mile from Lake Erie & Western Railroad station at Kokomo, on the west side of the track, on the east side of the concrete pavement of South Buckeye Street 35 yards south of West King Street, 50 yards north of a switch leading into a coal yard, 7.680 meters (25.2 feet) west of the west and nearest rail of main track. The station mark is a bronze tablet set in the concrete pavement. The reference mark is on the curbing east of the station, 3.14 meters (10.3 feet) from the station in azimuth 258° 38′.

Kokomo (Howard County, J. S. Bilby, 1920).—About one-eighth mile north of the Lake Erie & Western Railroad station, on the west side of the track, 6 yards north of Monroe Street, one-fourth mile south of Pennsylvania Railroad station, 15 yards west of Danners Wholesale Store, 1.905 meters (6.25 feet) west of the west and nearest rail of the main track. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 14.395 meters (47.23 feet) from the station in azimuth 339° 29′.

Penn (Howard County, J. S. Bilby, 1920).—At Kokomo Junction, just west of North Main Street, on the south side of the Pennsylvania Railroad, also on east side of the Lake Erie & Western Railroad, where Pennsylvania Railroad crosses it, 18 yards northwest of Kokomo Junction station, 1.715 meters (5.63 feet) south of south and nearest rail on Pennsylvania Railroad, 2.850 meters (9.35 feet) east of the east rail of the Lake Erie & Western Railroad. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a[1]. There is no reference mark.

Lacy (Howard County, J. S. Bilby, 1920).—One mile north of Kokomo, on the east side of the Pennsylvania Railroad, about 100 yards south of yard tower, about 325 yards northwest of the Hoosier Iron Works, 430 yards northeast of the Great Western Pottery Co., 380 yards north of Morgan Street crossing, 2.140 meters (7.02 feet) east of east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.590 meters (38.02 feet) from the station in azimuth 330° 01′.

Cassedy (Howard County, J. S. Bilby, 1920).—About 3½ miles north of Kokomo, on west side of railroad track, one-fourth mile north of milepost C 164, three-eighths mile south of County Line interurban station, 2.820 meters (9.25 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 15.145 meters (49.69 feet) from the station in azimuth 241° 25′.

Shope (Cass County, J. S. Bilby, 1920).—About 2 miles south of Walton, on the east side of the Pennsylvania Railroad tracks, 325 yards north of milepost C 170, 100 yards north of the road crossing at Shope interurban station, 3.225 meters (10.58 feet) east of east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 9.135 meters (29.97 feet) from the station in azimuth 211° 01′.

Bennett (Cass County, J. S. Bilby, 1920).—About three-fourths mile south of Walton, on the west side of the Pennsylvania Railroad, 490 yards north of milepost C 171, 50 yards south of a road crossing, 190 yards south of the switch signal for south yard siding for Walton, 2.785 meters (9.14 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as

[1] See pp. 27 and 28.

described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 11.915 meters (39.09 feet) from the station in azimuth 59° 57′.

Laporte (Cass County, J. S. Bilby, 1920).—About 2 miles north of Walton, on the east side of the track, 50 yards north of a road crossing, 60 yards northeast of Mr. Sayton's residence, 5.745 meters (18.85 feet) east of the east and nearest rail, 700 yards north of milepost C 174. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side as the station, 7.660 meters (25.13 feet) from it in azimuth 181° 29′.

Anoka (Cass County, J. S. Bilby, 1920).—Station is 5 miles south of Logansport, on the east side of the track, 160 yards north of the Anoka railroad station, 100 yards north of the overhead bridge No. 176 over the public highway, 50 yards south of the switch signal for the siding at Anoka Junction, 30 yards southwest of J. H. Masters' residence, 6.495 meters (21.31 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the east side of the track, 3.535 meters (11.60 feet) from the station in azimuth 153° 00′.

Junction (Cass County, J. S. Bilby, 1920).—Three and one-half miles south of Logansport, on the east side of the track, 3 yards east of the highway bridge over the Pennsylvania Railroad line, one-fourth mile northeast of the junction tower, 14.982 meters (49.15 feet) from the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.882 meters (38.98 feet) from the station in azimuth 110° 42′.

Laurra (Cass County, J. S. Bilby, 1920).—Four miles south of Logansport, on the east side of the track, one-half mile north of Anoka Junction, 25 yards north of the road crossing that leads off to the east from what is known as the "Seven Mile Pike," 325 yards northwest of P. K. Schaffer's residence, 2.115 meters (6.94 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 6.480 meters (21.26 feet) from the station in azimuth 185° 26′.

Frate (Cass County, J. S. Bilby, 1920).—Two and one-half miles south of Logansport Pennsylvania Railroad depot, 1 yard northwest of the Logansport south yard semaphore signal, 200 yards northwest of the hump used for switching cars, about 160 yards southeast of the tool house, 2.040 meters (6.69 feet) southwest of the nearest rail of the outgoing track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Yarde (Cass County, J. S. Bilby, 1920).—About 550 yards east of the Eighteenth Street crossing, on the west side of the track, in the Logansport south yards, 330 yards west of the tool house, 2.415 meters (7.92 feet) west of the west and nearest rail of the main outgoing track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Wabash (Cass County, J. S. Bilby, 1920).—The station is 1½ miles south of the Pennsylvania Railroad depot at Logansport, on the west side of the track, 160 yards south of the railroad bridge over the Wabash River, about 50 yards north of the milepost C 196, 85 yards north of the switch tower, 5.135 meters (16.85 feet) west of the west and nearest rail of the outgoing track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

River (Cass County, J. S. Bilby, 1920).—The station is three-fourths of a mile from the Pennsylvania Railroad station at Logansport, on the west side of the track, 40 yards southeast of the Fourteenth Street switch tender, 325 yards west of the machine shop of the Pennsylvania Railroad, 1.740 meters (5.71 feet) west of the west and nearest rail of the outgoing track. The station and reference marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Lagrange (Cass County, J. S. Bilby, 1920).—One-half mile from the Pennsylvania Railroad depot at Logansport, on the east side of the track, 65 yards north of the Pennsylvania Railroad freight depot, 165 yards southeast of milepost C 197, 2.120 meters (6.95 feet) east of the east and nearest rail of the incoming track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Mulborn (Cass County, J. S. Bilby, 1920).—About 165 yards east of the Pennsylvania Railroad station at Logansport, 20 yards south of the Caruso & Co. warehouse, in the middle of the street on the east side of the track, 5.215 meters (17.11 feet) east of the east and nearest rail of the westbound main track. The station and under ground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

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[1] See pp. 27 and 28.

Logansport (Cass County, J. S. Bilby, 1920).—About 165 yards west of the Pennsylvania Railroad depot at Logansport on the west side of the track, at the north end of the west curbing of the South Third Street bridge over the Wabash River, 11.740 meters (38.52 feet) west of the west and nearest rail of the eastbound main track, 0.650 meter (2.13 feet) from the end of the curb. The station mark is a bronze tablet set in the concrete pavement. There is no reference mark.

Eel (Cass County, J. S. Bilby, 1920).—One-half mile north of the Pennsylvania Railroad station on Third Street Bridge over the Eel River, 21.960 meters (72.05 feet) from the curve in the south end of the bridge (south end of the abutment), 0.910 meter (2.99 feet) from the edge of the curb. The station is marked by a bronze tablet set in the concrete sidewalk. There is no reference mark.

Miami (Cass County, J. S. Bilby, 1920).—About 330 yards south of the Vandalia Railroad station at Logansport, 65 yards north of Miami Avenue on the west side of Third Street, in the east end of the sidewalk, opposite George Petrie's garage, 1.605 meters (5.27 feet) west of the west curbstone of Third Street. The station is marked by a bronze tablet set in the concrete walk. There is no reference mark.

Vandalia (Cass County, J. S. Bilby, 1920).—About 80 yards east of the Vandalia Railroad station, on the east side of Third Street just east of the sidewalk, 7 yards south of the watchman's tower, 3.700 meters (12.14 feet) east of the east curbstone of Third Street, 2.445 meters (8.02 feet) south of the south and nearest rail of the Michigan division of the Vandalia Railroad. There is no reference mark.

Leonda (Cass County, J. S. Bilby, 1920).—Three-fourths mile north of the Vandalia Railroad depot, on the north side of the Michigan division track, 6 yards west of the center of Michigan Avenue, in the west end of the concrete sidewalk, 3.525 meters (11.56 feet) north of the north and nearest rail of the Michigan division track of the Vandalia Railroad. The station is marked by a bronze tablet, set in the concrete walk. There is no reference mark.

Knox (Cass County, J. S. Bilby, 1920).—One mile from the Vandalia station, on the east side of the South Bend division of the Vandalia Railroad track, 150 yards east of Cummings Street, about 100 yards east of B. C. Williams's residence, 18.390 meters (60.34 feet), east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 8.07 meters (26.48 feet) from the station in azimuth 72° 23′.

Horney (Cass County, J. S. Bilby, 1920).—One and one-half miles north of Logansport, on the east side of the track, 150 yards south from end of first curve north of Logansport, 100 yards south of the railroad bridge, 9.359 meters (30.71 feet) east of the east and nearest track. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 16.800 meters (55.12 feet) from the station in azimuth 189° 30′.

Laurence (Cass County, J. S. Bilby, 1920).—Two miles north of Logansport, on the west side of the track, 100 yards north of Michigan Avenue, 2 yards north of the railroad bridge No. 116-28, 2.700 meters (8.86 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a. The reference mark is on the same (west) side of the track, 11.460 meters (37.60 feet) from the station in azimuth 62° 53′.

Lawn (Cass County, J. S. Bilby, 1920).—About 3¼ miles north of Logansport, on the east side of the track, 150 yards north of third curve north of Logansport, 180 yards north of milepost T. H. 118, 50 yards north of railroad bridge No. 118–03, 11.5 meters (37.73 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 13.760 meters (45.14 feet) from the station in azimuth 186° 40′.

Martha (Cass County, J. S. Bilby, 1920).—About 3½ miles north of Logansport, on the east side of the track, 150 yards north of railroad bridge No. 118–08, one-half mile north of milepost T. H. 118, one-quarter mile south of Read crossing, 12.280 meters (40.29 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 5.290 meters (17.36 feet) from the station in azimuth 180° 55′.

Madison (Cass County, J. S. Bilby, 1920).—Four miles north of Logansport, on the west side of the track, about 200 yards north of Read crossing, 40 yards south of railroad bridge No. 118–24, 190 yards north of Ernest Wolf's residence, 2.320 meters (7.61 feet) west of the west and nearest rail. The station, underground, and reference marks

[1] See pp. 27 and 28.

are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 19.955 meters (65.47 feet) from the station in azimuth 294° 51′.

Marion (Cass County, J. S. Bilby, 1920).—About 4½ miles north of Logansport, on the east side of the track, about 200 yards north of milepost T. H. 119, 80 yards southwest of Mrs. Stackhouse's residence, 8.339 meters (27.36 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 18.450 meters (60.53 feet) from the station in azimuth 326° 53′.

Marchal (Cass County, J. S. Bilby, 1920).—Six miles north of Logansport, on the west side of the track, about 275 yards north of the road crossing, 500 yards south of milepost T. H. 121, also on top of a deep cut, 7.905 meters (25.94 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is 12.140 meters (39.83 feet) from the station in azimuth 137° 09′.

Martin (Cass County, J. S. Bilby, 1920).—On the west side of the track, 1 mile south of Lucerne, 30 yards north of the dirt-road crossing, 500 yards north of the milepost T. H. 123, 8.440 meters (27.69 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.97 meters (39.27 feet) from the station in azimuth 142° 51′.

Monroe (Cass County, J. S. Bilby, 1920).—About three-fourths mile south of Lucerne, on the west side of the track, three-eighths mile south of the milepost T. H. 124, north of the east bank of the third cut south of Lucerne, 6.060 meters (19.88 feet) west of the west and nearest rail. The reference mark is on the same side of the track. The station is marked by a 2 by 4 stake and a nail with a cross on the head. The reference mark is a pine stake with an arrow sawed on the top pointing toward the station, and 9.21 meters (30.22 feet) from it in azimuth 128° 21′.

Lucerne (Cass County, J. S. Bilby, 1920).—About three-fourths mile north of Lucerne, on the east side of the track, 80 yards south of milepost T. H. 125, 50 yards north of the south end of the first cut north of Lucerne, 6.235 meters (20.46 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 17.08 meters (56.04 feet) from the station in azimuth 188° 23′.

Boon (Cass County, J. S. Bilby, 1920).—About 1½ miles north of Lucerne, on the west side of the track, one-half mile north of the milepost T. H. 125, 500 yards south of the first road crossing north of the Lucerne railroad station, 330 yards south of A. W. Cary's residence, 4.810 meters (15.78 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 9.270 meters (30.41 feet) from the station in azimuth 132° 50′.

Montgomery (Cass County, J. S. Bilby, 1920).—Three miles north of Lucerne, 1½ miles south of Grass Creek, on the west side of the track, 250 yards south of a wagon road crossing, 150 yards north of milepost T. H. 127, on the north end of the first curve north of Lucerne. 13.690 meters (44.92 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.100 meters (36.42 feet) from the station in azimuth 189° 13′.

Morgan (Fulton County, J. S. Bilby, 1920).—About 1½ miles south of Grass Creek, 500 yards north of milepost T. H. 128, on the east side of the track, on the first deep cut south of Grass Creek, 8.712 meters (28.58 feet) east of the east and nearest rail. The station and reference marks are marked by a 2 by 4 pine stake with a nail and a cross on the top. The reference mark is on the same side of the track, 10.005 meters (32.82 feet) from the station in azimuth 350° 50′.

Grass (Fulton County, J. S. Bilby, 1920).—About 1½ miles north of Grass Creek, on the west side of the track, 50 yards northwest of milepost T. H. 131, on the first curve north of Grass Creek, 8.635 meters (28.33 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 10.295 meters (33.78 feet) from the station in azimuth 150° 30′.

Newton (Fulton County, J. S. Bilby, 1920).—About 1½ miles south of Kewanna, on the east side of the track, 40 yards north of wagon road crossing, 65 yards west of Ralph Hamilton's barn, 4.770 meters (15.65 feet) east of the east and nearest rail.

[1] See pp. 27 and 28.

The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 10.005 meters (32.82 feet) from the station in azimuth 292° 51′.

Noble (Fulton County, J. S. Bilby, 1920).—About three-fourths mile south of Kewanna, on the west side of the track, one-half mile north of milepost T. H. 134, on north end of first cut south of Kewanna, 200 yards south of switch signal, 10.07 meters (33.03 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The refernce mark is on the same side of the track near the fence line, 7.100 meters (23.30 feet) from the station in azimuth 140° 23′.

Kewanna (Fulton County, J. S. Bilby, 1920).—About three-eighths of a mile north of Kewanna, on the west side of the Vandalia Railroad track, 130 yards north of milepost T. H. 135, 200 yards east of the Chesapeake & Ohio Railway station at Kewanna, 35 yards north of the Vandalia and the Chesapeake & Ohio Railway crossing, 4.04 meters (13.25 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 6.745 meters (which equals 22.13 feet, but the notes show a measurement of 20.56 feet, and it is not known which is correct), from the station in azimuth 155° 12′.

Ohio (Fulton County, J. S. Bilby, 1920).—One and one-half miles north of Kewanna, on the west side of the track, 50 yards north of a wagon road croosing, one-half mile north of milepost T. H. 136, 8.78 meters (28.80 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 11.64 meters (38.19 feet) from the station in azimuth 16° 47′.

Orange (Fulton County, J. S. Bilby, 1920).—Two miles north of Kewanna, on the west side of the track, 125 yards south of milepost T. H. 137, 90 yards north of a wagon road crossing, 10.575 meters (34.69 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 15.26 meters (which equals 50.07 feet, but the notes show a measurement of 46.47 feet, and it is not known which is correct), from the station in azimuth 182° 45′.

Owen (Fulton County, J. S. Bilby, 1920).—Four and one-fourth miles north of Kewanna, on the east side of the track, 150 yards north of milepost T. H. 139, 400 yards south of a wagon road crossing, 500 yards north of a water tower, 5.030 meters (16.50 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same (east) side of the track, 10.52 meters (34.51 feet) from the station in azimuth 236° 13′.

Park (Fulton County, J. S. Bilby, 1920).—About 2½ miles south of Delong, on the east side of the track, 190 yards south of a wagon road crossing, three-eights mile south of milepost T. H. 141, 5.09 meters (16.70 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 10.245 meters (33.61 feet) from the station in azimuth 239° 25′.

Perry (Fulton County, J. S. Bilby, 1920).—About 1¼ miles south of Delong, on the west side of the track, 35 yards northwest of milepost T. H. 142, 21.15 meters (69.39 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 7.77 meters (25.49 feet) from the station in azimuth 268° 28′.

Delong (Fulton County, J. S. Bilby, 1920).—About one-eighth mile north of Delong, on the east side of the track, 75 yards north of a wagon road crossing, 80 yards north of the north end of the station platform at Delong, 300 yards north of milepost T. H. 143, 130 yards north of the northwest corner of the depot. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track near the fence line, 16.035 meters (52.61 feet) from the station in azimuth 96° 05′.

Porter (Fulton County, J. S. Bilby, 1920).—About 2¾ miles north of Delong, on the east side of the track, three-eighths mile south of milepost T. H. 146, 200 yards northwest of Mrs. Frank Hawk's residence, 11.22 meters (36.81 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the

[1] See pp. 27 and 28.

same side of the track near the fence line, 4.85 meters (15.91 feet) from the station in azimuth 314° 30′.

Posey (Marshall County, J. S. Bilby, 1920).—About 1½ miles south of Culver, on the east side of the track, 3 yards north of a wagon road crossing, 25 yards south of milepost T. H. 147, 325 yards south of a gravel pit 220 yards south of switch signal for gravel-pit siding, 2.11 meters (6.92 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, near the east-and-west fence line, 14.07 meters (46.16 feet) from the station in azimuth 317° 06′.

Putnam (Marshall County, J. S. Bilby, 1920).—One mile south of Culver, on the west side of the track, 270 yards south of milepost T. H. 148, 45 yards north of a road crossing, 100 yards south of Medborne ice plant, directly west of the switch signal for ice-plant siding, 5.75 meters (18.86 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 3.01 meters (9.88 feet) from the station in azimuth 91° 43′.

Culver (Marshall County, J. S. Bilby, 1920).—About 100 yards west of the railroad station at Culver, on the east side of the track, 325 yards east of railroad bridge 148–26, 220 yards east of the switch signal for siding, 80 yards south of F. G. Solomon's merchandise store, 2.75 meters (9.02 feet) east of the east and nearest rail. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Randolf (Marshall County, J. S. Bilby, 1920).—About one-fourth mile north of Culver, on the east side of the track, 275 yards north of milepost T. H. 149, 150 yards north of switch signal for siding, 100 yards south of a road crossing, 13.34 meters (43.77 feet) east of the east and nearest rail of the main track. The station, underground, and reference marks are bronze tablets set in concrete, as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 9.885 meters (32.43 feet) from the station in azimuth 233° 13′.

Riple (Marshall County, J. S. Bilby, 1920).—Two miles north of Culver, on the east side of the track, at the second curve north of Culver, 650 yards north of the road crossing, on the north end of the second cut north of Culver Military Academy, 5.48 meters (17.98 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 12.78 meters (41.93 feet) from the station in azimuth 256° 18′.

Rush (Marshall County, J. S. Bilby, 1920).—About 2½ miles north of Culver, on the east side of the track, 125 yards south of milepost T. H. 151, three-fourths mile south of the Vandalia-Nickel Plate crossing, 50 yards east of H. S. McGowan's residence, 5.85 meters (19.20 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 71, and 11a.[1] The reference mark is on the same side of the track near the fence line, 17.52 meters (57.48 feet) from the station in azimuth 0° 02′.

Hibbard (Marshall County, J. S. Bilby, 1920).—On the west side of the track, one-fourth mile north of Hibbard railroad station, 165 yards north of milepost T. H. 152, 6 yards south of the north switch signal for the siding, 2.625 meters (8.62 feet) west of the west and nearest rail. The station is marked by a 2 by 4 stake with a nail in the top. The reference mark is the same, and is 10.825 meters (35.52 feet) from the station in azimuth 118° 27′.

Spencer (Marshall County, J. S. Bilby, 1920).—Five miles south of Plymouth, on the east side of the track, 4 miles north of Hibbard, on the extension of the tangent of the first curve north of Hibbard, three-eighths mile north of the milepost T. H. 155, east of Twin Lakes, 90 yards southwest of George Nickel's residence, 40 yards north of the road crossing, 6.315 meters (20.71 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 8.045 meters (26.40 feet) from the station in azimuth 287° 40′.

Twin (Marshall County, J. S. Bilby, 1920).—About 4½ miles south of Plymouth, on the west side of the Vandalia Railroad, three-eighths mile south of the milepost T. H. 156, 25 yards west of the road crossing, also on the north end of the first reverse curve north of Hibbard, on the extension of the northern tangent, also on the west bank of a deep cut, 13.250 meters (43.4 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as

[1] See pp. 27 and 28.

described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 8.47 meters (27.79 feet) from the station in azimuth 31° 40′.

Joseph (Marshall County, J. S. Bilby, 1920).—Two miles south of Plymouth, on the west side of the track, one-fourth mile south of the milepost T. H. 158, 200 yards east of J. M. Black's barn, 25 yards north of lane leading from said barn, 6.355 meters (20.85 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 13.195 meters (43.29 feet) from the station in azimuth 72° 36′.

Starke (Marshall County, J. S. Bilby, 1920).—About 1¼ miles south of Plymouth, on the east side of the track, 220 yards north of the milepost T. H. 158, 50 yards north of the north end of the second curve south of Plymouth, 25 yards north of the battery box for the semaphore signal system, 2.770 meters (9.09 feet) east of the east and nearest rail of the Vandalia Railroad. The station and underground marks are tablets set in concrete as described in notes 1a and 7a.[1] There is no reference mark.

Stuben (Marshall County, J. S. Bilby, 1920).—About one-sixth mile south of Plymouth, on the east side of the Vandalia Railroad, 130 yards south of street crossing, 60 yards north of the semaphore signal, 190 yards south of the Pennsylvania Railroad main-line crossing, 2.600 meters (8.53 feet) east of the east and nearest rail. The station and underground marks are bronze tablets set in concrete as described in notes 1a, and 7a.[1] There is no reference mark.

Plymouth (Marshall County, J. S. Bilby, 1920).—On the north end of the Vandalia Railroad station platform at Plymouth, on the east side of the track, 100 yards north of the milepost T. H. 159, 45 yards south of the West Garre Street crossing, 30 yards south of the watchtower, 1.570 meters (5.15 feet) east of the east and nearest rail, 0.790 meter (2.59 feet) east of the platform curb. The station mark is a bronze tablet set in cement in the brick pavement which forms the railroad station platform. There is no reference mark.

Sullivan (Marshall County, J. S. Bilby, 1920).—On the west side of the track, 1¼ miles north of Plymouth, 190 yards south of milepost T. H. 160, 190 yards northwest of the box factory, 80 yards north of the box-factory siding, 1.425 meters (4.67 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 29.09 meters (95.44 feet) from the station in azimuth 321° 16′.

Switzerland (Marshall County, J. S. Bilby, 1920).—About 2½ miles north of Plymouth, on the west side of the Vandalia Railroad, three-eighths mile north of the milepost T. H. 161, on the south edge of the second deep cut north of Plymouth, 100 yards west of Mrs. Elizabeth Rober's residence, 15 yards north of the road leading from said residence across the track to the west, 7.770 meters (25.49 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 6.545 meters (21.47 feet) from the station in azimuth 120° 23′.

Harris (Marshall County, J. S. Bilby, 1920).—About 4½ miles north of Plymouth, on the east side of Vandalia track, 30 yards north of the road crossing, one-eighth mile north of milepost T. H. 163, 35 yards north of the switch signal for the siding, three-fourths mile south of the water tank, 6.160 meters (20.21 feet) east of the east and nearest rail of the Vandalia tracks. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 6.67 meters (21.88 feet) from the station in azimuth 272° 51′.

Tippecanoe (Marshall County, J. S. Bilby, 1920).—Three miles south of Lapaz, on the west side of the track, 425 yards north of the railroad station at Harris, 50 yards south of the north switch signal for siding, one-half mile north of the water tower, 6.08 meters (19.95 feet), west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 11.52 meters (37.79 feet) from the station in azimuth 174° 14′.

Lapaz (Marshall County, J. S. Bilby, 1920).—About three-fourths mile south of Lapaz railroad station, on the east side of the track, one half mile south of milepost T. H. 167, 40 yards north of a wagon road crossing 6.310 meters (20.70 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is

[1] See pp. 27 and 28.

on the same side of the track near the fence line, 8.285 meters (27.18 feet) from the station in azimuth 301° 49′.

Union (St. Joseph, J. S. Bilby, 1920).—About 2½ miles south of Lakeville, on the west side of the track, 380 yards south of wagon road crossing, one-half mile south of milepost T. H. 170, on extension of south tangent of first curve north of Lapaz, 7.495 meters (24.59 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 6.345 meters (20.82 feet) from the station in azimuth 117° 39′.

Mourhess (St. Joseph, J. S. Bilby, 1920).—About 1½ miles south of Lakeville, on the east side of track, 30 yards south of milepost T. H. 171, 80 yards north of road crossing, south end of the second curve south of Lakeville, 13.470 meters (44.19 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 13.10 meters (42.98 feet) from the station in azimuth 189° 23′.

Aman (St. Joseph County, J. S. Bilby, 1920).—About three-fourths mile south of Lakeville, on the west bank of the first cut south of Lakeville, 70 yards south of N. Eldred's residence, 25 yards from Lakeville-Lapaz highway, 165 yards south of a road crossing, 46.740 meters (153.35 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track, 29.47 meters (96.69 feet) from the station in azimuth 331° 48′.

States (St. Joseph County, J. S. Bilby, 1920).—One mile north of Lakeville, on the east side of the track, 15 yards north of a road crossing, the first north of Lakeville, and three-eighths mile south of milepost T. H. 173, 7.05 meters (23.13 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 9.26 meters (30.38 feet) from station in azimuth 226° 00′.

Hilberry (St. Joseph County, J. S. Bilby, 1920).—About 4½ miles north of Lakeville, on the east side of the track, one-half mile north of milepost T. H. 175, 325 yards south of road crossing, 325 yards west of Michael Wilhelm's residence, 7.757 meters (25.45 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same (east) side of the track near the fence line, 5.40 meters (17.72 feet) from the station in azimuth 198° 41′.

Peacock (St. Joseph County, J. S. Bilby, 1920).—Six miles south of South Bend on the west side of the track, 450 yards south of a road crossing, 550 yards south of milepost T. H. 178, 5.775 meters (18.95 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 9.66 meters (31.69 feet) from the station in azimuth 53° 10′.

Wehr (St. Joseph County, J. S. Bilby, 1920).—About 5½ miles south of South Bend on the west side of the track, one-fourth mile north of milepost T. H. 178, 450 yards south of road crossing, 8.41 meters (27.60 feet) west of the west and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 5.315 meters (17.44 feet) from the station in azimuth 134° 48′.

Lloyd (St. Joseph County, J. S. Bilby, 1920).—About 1½ miles south of South Bend, on the east side of the track, 550 yards north of a road crossing, near the middle of the fence enclosing large factory site, 9.60 meters (31.50 feet) east of the east and nearest rail. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the same side of the track near the fence line, 8.835 meters (28.99 feet) from the station in azimuth 357° 26′.

Studebaker (St. Joseph County, J. S. Bilby, 1920).—About 1¼ miles south of South Bend, on the east side of the track, 200 yards south of foundry, 130 yards north of switch signal which joins railroad to electric line. The station and reference mark are stakes with nails in the tops. The reference mark is on the east side of the track, 11.885 meters (39.00 feet) from the station in azimuth 200° 13′.

Griffith (St. Joseph County, J. S. Bilby, 1920).—One mile from the center of South Bend, in the suburbs, on the east side of the track, on the extension of the northern tangent, 150 yards south of milepost T. H. 181, 125 yards south of International India Rubber Corporation factory, 25 yards south of railroad bridge 180-38, 3.03 meters

[1] See pp. 27 and 28.

(9.94 feet) east of the east and nearest rail. The station, and underground marks are bronze tablets set in concrete as described in notes 1a, and 7a.[1] There is no reference mark.

Indiana (St. Joseph County, J. S. Bilby, 1920).—Seven blocks south of the Vandalia depot at South Bend, on the east side of the track, in center of Indiana Avenue, 75 yards west of Main Street, 10 yards south of south end of International Lumber Co., 75 yards southeast of South Bend Foundry Co., 1.61 meter (5.28 feet) east of east and nearest rail. The station is marked by a bronze tablet set in center of concrete street. The reference mark is a bronze tablet set in the concrete curbing of street, 20.285 meters (66.55 feet) from the station in azimuth 282° 35.[1]

South Bend (St. Joseph County, J. S. Bilby, 1920).—In South Bend, on the edge of a sewer manhole at the intersection of East Indiana Avenue and South Miami Street, 25 yards southeast of the First Church of the Brethren, 4.455 meters (14.62 feet) west of the east curb of South Miami Street, 5.565 meters (18.26 feet), northeast of the nearest rail of street car track. The station is marked by a cross filed and letters U. S. C. & G. S., 1920 stamped on iron rim of sewer manhole. There is no reference mark.

Bud (St. Joseph County, J. S. Bilby, 1920).—About 1¼ miles east of New York Central depot, on the south side of the New York Central track, in the center of South Miami Street, 50 yards southeast of semaphore signal 452–1, 15 yards east of the watchman's shelter, 2.355 meters (7.73 feet) south of the south and nearest rail of the eastbound track, 4.29 meters (14.07 feet) east of the west curb of South Miami Street. Marked by bronze tablet set in concrete in the center of the brick pavement of South Miami Street. The reference mark is a brass tablet set in concrete in the west curb of South Miami Street, 4.42 meters (14.50 feet) from the station in azimuth 87° 08′.

Lincoln (St. Joseph County, J. S. Bilby, 1920).—About 1¾ miles east of New York Central depot at South Bend, on the south side of New York Central track, 15 yards southeast of the watchman's shelter, 25 yards east of the Vernon Street crossing, 380 yards west of milepost B 425, and 9.455 meters (31.02 feet) south of the south and nearest rail of the eastbound track. The station and underground marks are bronze tablets set in concrete as described in notes 1a and 7a.[1] The reference mark is a bronze tablet set in the edge of the concrete sidewalk and is on the same side of the track, 10.555 meters (34.63 feet) from the station in azimuth 46° 35′.

South Bend west base (St. Joseph County, J. S. Bilby, 1920).—About 2½ miles east of South Bend, on the south side of the New York Central track, 225 yards southwest of the entrance to Springbrook Park, 100 yards east of the first deep fill east of South Bend, 130 yards east of milepost C 88, 550 yards west of the semaphore signal 451–2, and 2.265 meters (7.43 feet) south of the south and nearest rail of the eastbound track. The station, reference, and underground marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the track, 10.075 meters (33.05 feet) from the station in azimuth 182° 05′.

South Bend east base (St. Joseph County, J. S. Bilby, 1920).—One mile west of Mishawaka depot, on the north side of the New York Central lines, 4 yards northwest of the South Meridian Street crossing, 1 meter west of the east sidewalk of South Meridian Street, and 3.77 meters (12.37 feet) north of the north and nearest rail of the westbound track. The station, underground, and reference marks are bronze tablets set in concrete as described in notes 1a, 7a, and 11a.[1] The reference mark is on the opposite side of the street near the pavement, 11.65 meters (38.22 feet) from the station in azimuth 87° 01′.

U. S. LAKE SURVEY TRIANGULATION, NORTHERN INDIANA.

PRINCIPAL POINTS.

Reading (U. S. L. S.) (Hillsdale County, Mich., U. S. Lake Survey, 1878).—In sec. 26, T. 7 S., R. 4 W., on the grounds of the Colby Wringer Co. factory, in the village of Reading. The elevation of the ground at the station above the mean level of Lake Michigan is 627.2 feet. The station is marked by two stone posts in the usual manner. Three reference posts are set as follows: One bearing N. 48° 28′ E., distant 135.8 meters (445.5 feet), one S. 83° 12′ E., distant 102.9 meters (337.6 feet), and one N. 86° 20′ W., distant 147.8 meters (484.9 feet). The southeast corner of the Colby Wringer Co. factory is distant 50.25 meters (164.9 feet) N. 51° 05′ W., the northwest corner of section 26, being the corner of sections 22, 23, 26, and 27, bears N. 44° 11′ W., distant 715.32 meters (2346.8 feet), and the northeast corner of section 26, which is the corner of sections 23, 24, 25, and 26, bears N. 65° 56′ 50″ E., distant 1235.9 meters (4054.8 feet).

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[1] See pp. 27 and 28.

Quincy (U. S. L. S.) (Branch County, Mich., U. S. Lake Survey, 1878).—About 2 miles northwesterly from Quincy railroad station, in the SW. ¼ sec. 8, T. 6 S., R. 5 W., on ground which is at an elevation of 478.9 feet above the mean level of Lake Michigan. The station is marked by two stone posts. Three stone reference posts were set, one S. 18° 02′ W. distant 41.5 meters (136.2 feet), one N. 16° 53′ W. distant 46.25 meters (151.7 feet), and one N. 35° 13′ E. distant 181.5 meters (595.5 feet). The first two are approximately on the line between sections 7 and 8. The quarter-section corner at the middle of the south side of section 7 bears S. 56° 55′ 10″ W. and is distant 980.5 meters (3216.9 feet).

Fremont (U. S. L. S.) (Steuben County, U. S. Lake Survey, 1878).—Located about 3 miles southwest of the village of Fremont, in sec. 31, T. 38 N., R. 14 E., on ground at an elevation of 560.2 feet above the level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one N. 22° 00′ W. distant 46.5 meters (152.6 feet), one S. 5° 15′ W. distant 55.7 meters (182.7 feet), and one N. 42° 29′ E. 22.9 meters (75.1 feet). The NW. cor. sec. 31 bears N. 28° 10′ W. and is distant 834.6 meters (2738.2 feet).

Bronson (U. S. L. S.) (Branch County, Mich., U. S. Lake Survey, 1878).—About 3 miles westerly from Bronson, in the SE. ¼ of SW. ¼ sec. 16, T. 7 S., R. 8 W., on ground at an elevation of 416.4 feet above the level of Lake Michigan. The station is marked by two stone posts. There are three stone reference posts, one N. 40° 13′ E. distant 106.5 meters (349.4 feet), one N. 85° 08′ E. distant 68.6 meters (225.1 feet), and one S. 36° 12′ E. distant 116.4 meters (381.9 feet). The quarter-section corner on the south side of section 16 bears S. 19° 07′ E. distant 208.9 meters (685.4 feet).

Mongo (U. S. L. S.) (La Grange County, U. S. Lake Survey, 1878).—About three-fourths mile northeast of Mongo Mills, in sec. 4, T. 37 N., R. 11 E., on ground at an elevation of 445.5 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference marks, one S. 59° 13′ E. distant 28.6 meters (93.8 feet), one S. 14° 19′ E. distant 16.7 meters (54.8 feet), and one S. 57° 03′ W. distant 30.1 meters (98.8 feet). The corner of sections 4, 5, 8, and 9 is S. 22° 44′ 00″ W. distant 873.5 meters (2865.8 feet).

Sherman (U. S. L. S.) (St. Joseph County, Mich., U. S. Lake Survey, 1878).—About 4 miles northwest of Sturgis, Mich., in the NE. ¼ sec. 22, T. 7 S., R. 10 W., on ground which is at an elevation of 455.7 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference marks, one S. 28° 58′ E. distant 45.9 meters (150.6 feet), one S. 21° 16′ W. distant 41.7 meters (136.8 feet), and one N. 70° 17′ W. distant 26.8 meters (87.9 feet). The quarter-section corner on the south side of section 22 is S. 24° 12′ 30″ W. distant 921.0 meters (3021.6 feet).

Van Buren (U. S. L. S.) (La Grange County, U. S. Lake Survey, 1878).—Located in NW. ¼ of sec. 33, T. 38 N., R. 8 E., at an elevation of 369.7 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one S. 3° 20′ W. distant 130.0 meters (426.5 feet), one N. 22° 59′ W. distant 27.6 meters (90.6 feet), and one S. 89° 11′ E. distant 175.9 meters (577.1 feet). The quarter-section corner on the west side of section 33 is S. 55° 44′ W. distant 752.4 meters (2468.5 feet).

Porter (U. S. L. S.) (Cass County, Mich., U. S. Lake Survey, 1878).—About 8 miles west of White Pigeon village, in NW. ¼ of sec. 36, T. 7 S., R. 13 W., at an elevation of 368.4 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one S. 48° 02′ E. distant 156.5 meters (513.5 feet), one N. 73° 29′ E. distant 120.6 meters (395.7 feet), and one N. 73° 24′ W. distant 108.3 meters (355.3 feet). The quarter-section corner on the west side of section 36 is S. 56° 55′ 03″ W. distant 1304.0 meters (4278.2 feet).

Jefferson (U. S. L. S.) (Elkhart County, U. S. Lake Survey, 1878).—About 3 miles south of Bristol, in the SW. ¼ sec. 2, T. 37 N., R. 6 E., at an elevation of 388.3 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one S. 27° 28′ W. distant 13.5 meters (44.3 feet), one N. 15° 01′ W. distant 23.6 meters (77.4 feet), and one N. 25° 44′ E. distant 95.0 meters (311.7 feet). The corner of sections 2, 3, 10, and 11 is S. 62° 43′ W. distant 350 meters (11.50 feet).

Calvin (U. S. L. S.) (Cass County, Mich., U. S. Lake Survey, 1878).—About 7 miles south of Vandalia, about 7 miles southeast of Cassopolis, in the NE. ¼ sec. 27, T. 7 S., R. 14 W., at an elevation of 429.3 feet above the mean elevation of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one N. 59° 28′ E. distant 44.6 meters (146.3) feet, one S. 21° 36′ E. distant 87.5 meters (287.1 feet), and one S. 9° 47′ W. distant 82.1 meters (269.4 feet). The quarter-

section corner on the west side of section 27 is S. 67° 07′ 30″ W. distant 1004.5 meters (3295.6 feet).

Milton (U. S. L. S.) (Cass County, Mich., U. S. Lake Survey, 1877; 1920).—In Milton Township, 4 miles east of Niles, in the SE. ¼ sec. 4, T. 8 S., R. 16 W., at an elevation of 314.1 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, two on the east side of the highway which is just west of the station, one S. 62° 30′ W. distant 131.8 meters (432.4 feet), and one N. 62° 03′ W. distant 130.9 meters (429.4 feet), and the third is at the center of section 4, N. 32° 06′ W. distant 230.4 meters (755.9 feet). The corner of sections 4, 5, 8, and 9 is S. 57° 12′ 45″ W. distant 1113.7 meters (3653.9 feet).

Penn (U. S. L. S.) (St. Joseph County, U. S. Lake Survey, 1877; 1920).—About 3 miles southeast of South Bend, in the NW. ¼ sec. 20, T. 37 N., R. 3 E., at an elevation of 309.3 feet above the mean level of Lake Michigan. The station is marked by stone posts. There are three stone reference posts, one N. 86° 30′ E. distant 99.7 meters (327.1 feet), one S. 7° 37′ E. distant 41.9 meters (137.5 feet), and one S. 51° 56′ W. distant 69.6 meters (228.3 feet). The corner of sections 17, 18, 19, and 20 is N. 63° 51′ W. distant 788.4 meters (2586.6 feet).

Carlisle (U. S. L. S.) (St. Joseph County, U. S. Lake Survey, 1877).—About 2 miles southwest of Carlisle, on what is known as Jarrett's Hill, in the SE. ¼ of sec. 11, T. 37 N., R. 1 W., at an elevation of 332.2 feet above the mean level of Lake Michigan. The station is marked by a stone post. There are three stone reference posts, one N. 32° 16′ W. distant 16.1 meters (52.8 feet), one S. 86° 16′ E. distant 14.4 meters (47.2 feet), and one S. 18° 24′ W. distant 8.7 meters (28.5 feet). The corner of sections 2, 3, 10, and 11 is N. 39° 09′ 30″ W. distant 1640.9 meters (5383.5 feet).

Bertrand (U. S. L. S.) (Berrien County, Mich., U. S. Lake Survey, 1877).—About 4 miles south of Buchanan, in the southeast corner of sec. 15, T. 8 S., R. 18 W., at an elevation of 356.9 feet above the mean level of Lake Michigan. The station is marked by a stone post as described in note 16.[1] There are three stone reference posts, one N. 2° 13′ W. distant 13.11 meters (43.0 feet), one S. 84° 13′ E. distant 9.69 meters (31.8 feet), which is on the line between sections 14 and 15, and one at the corner of sections 14, 15, 22, and 23, S. 2° 46′ 45″ E. distant 309.7 meters (1016 feet).

Galena (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1877).—About 4 miles northwest of Rolling Prairie, one-fourth mile northeast of a schoolhouse and cemetery at the corner of sections 31 and 32, in the SW. ¼ sec. 32, T. 38 N., R. 2 W., at an elevation of 375.9 feet above the mean level of Lake Michigan. The station is marked by a stone post as described in note 16.[1] There are three stone reference posts, one S. 32° 24′ W. distant 60.0 meters (197 feet), one S. 84° 19′ W. distant 62.1 meters (203.7 feet), and one S. 84° 43′ E. distant 36.6 meters (120 feet). A land survey stone on the south line of section 32, one-fourth mile east of the southwest corner of that section, is S. 8° 06′ E. distant 214.0 meters (702 feet).

Bald Tom (U. S. L. S.) (Berrien County, Mich., U. S. Lake Survey, 1874).—About three-fourths mile northwest of Brown railroad station, on the highest hill in the vicinity, in the SW. ¼ sec. 35, T. 6 S., R. 20 W., at an elevation of 240.1 feet above the mean level of Lake Michigan. The station is marked by a stone post as described in note 16.[1] There are three stone reference posts, one S. 43° 34′ W. distant 19.37 meters (63.6 feet), one N. 46° 34′ W. distant 7.56 meters (24.8 feet), and one N. 74° 12′ E. distant 22.25 meters (73 feet). The southeast corner of section 35 is S. 52° 01½′ E. distant 1038.9 meters (3408.5 feet). This station was reported "not found" in 1907.

Michigan City, 1877 (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1877).—Lost.

Springville (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1874).—In the SE. ¼ sec. 10, T. 37 N., R. 3 W., 13 meters (14 yards) north of a private road, 245 meters (268 yards) west of the road leading south to LaPorte, and near the south edge of a grove of high timber. The station is marked by a ½-inch drill hole in the top of a dressed stone 6 by 6 by 24 inches, set vertically in the ground with its top 2½ feet below the surface. Two reference stones are set in the road east of the station, one bearing N. 63° 43′ E. distant 273.81 meters (898.3 feet) and the other S. 86° 14′ E. distant 245.25 meters (804.6 feet). A third reference post is S. 6° 15′ E. (magnetic) distant 13 meters (42.7 feet). The SE. cor. sec. 10 is S. 86° 00′ E. distant 252.46 meters (828.3 feet).

Otis (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1874).—In sec. 10, T. 36 N., R. 4 W., 36 meters (118 feet) south of an east and west road, and 63.5 meters (208 feet) east of the section line between sections 9 and 10. The station is marked by a ½-inch drill hole in a cut stone 6 by 6 by 24 inches, set vertically in the ground with the

[1] See pp. 27 and 28.

top about 3 feet below the surface and directly above this is another stone rising to within 6 inches of the surface. Two reference stones are set in the road north of the station, one is N. 45° W. distant 49.36 meters (161.9 feet), and the other is N. 38° 30′ E. distant 47.32 meters (155.2 feet). The corner of sections 3, 4, 9, and 10 bears N. 9° 08′ 25″ W., distant 441.7 meters (1449 feet).

Millers (U. S. L. S.) (Lake County, U. S. Lake Survey, 1874).—On a sand dune, about 2 miles northeast of Millers station on the Lake Shore & Michigan Southern Railway, in sec. 33, T. 37 N., R. 7 W., on ground which is at an elevation of 128 feet above the mean level of Lake Michigan. The station is marked by a stone post set with the top 2 feet below the surface of the ground. There are three stone reference posts, one north (magnetic) 3.77 meters (12.4 feet), one south (magnetic) 3.74 meters (12.3 feet), and one west (magnetic) 4.9 meters (16 feet). This station was reported "not found" in 1908.

Shot Tower (U. S. L. S.) (Cook County, Ill., U. S. Lake Survey, 1874).—The tower was not in existence in 1908.

SUPPLEMENTARY POINTS.

Michigan City, 1908 (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908).—On top of the highest hill in the vicinity, the top of which has been blown away, 2 miles northeasterly from the harbor entrance of Michigan City, 250 meters from the shore of Lake Michigan, and 900 meters northwesterly from the Michigan Central Railroad, in sec. 22, T. 38 N., R. 4 W. The station is marked by a 40-penny nail in the top of an oak post which is about 4 feet long and 5 inches square, set vertically in the ground with the top 3 feet below the surface. The ground at the station is about 145 feet above Lake Michigan.

Field (U. S. L. S.) (Porter County, U. S. Lake Survey, 1908).—On property belonging to John S. Field of Chicago, 2¼ miles southwesterly from the harbor piers at Michigan City, on the summit of the highest sand hill in the vicinity, about 100 meters (110 yards) from the lake, and 200 meters (220 yards) west of a ditch which drains a large marsh south of the hills. There are a few pine trees on the north side of the hill, but the timber is mostly scrub oak and brush. The station is marked by 30-penny nail set point up in a block of concrete 6 by 6 by 36 inches set so as to project about 2 inches above the surface of the ground. The top of the monument is marked "U. S. 1908."

Hoosier (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908).—About three-eighths mile west of the harbor piers at Michigan City, on the summit of the high wooded hill at the west end of Hoosier Slide. The station is the center of a gas pipe which is driven several feet into the ground with the top about flush with the surface.

City West (U. S. L. S.) (Porter County, U. S. Lake Survey, 1908).—About 8¾ miles westerly from Michigan City, about one-fourth mile east of a creek which flows into the lake, 300 meters (330 yards) back from the lake shore, on the summit of the highest and most westerly of three prominent hills, the eastern one of which is known as Mount Tom, and the center one is nearest to the lake. These hills are covered with scattering scrub timber. The station is marked by a 30-penny nail set point up in a block of concrete, 6 by 6 by 36 inches, set vertically in the ground with the top projecting about 1 inch above the surface. The top of the monument is marked "U. S. 1908."

Dune Park (U. S. L. S.) (Porter County, U. S. Lake Survey, 1908).—About 13⅝ miles from Michigan City, 9⅝ miles from Gary Harbor, on the highest hill, covered with scrub timber, in the section between Dune Park and the lake, and about one-fourth mile from the lake. The station is marked by a 30-penny nail set in a concrete block about 6 by 6 by 36 inches set so that the top projects about 1 inch above the surface. The top of the monument is marked "U. S. 1908."

Sabinsky (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—About 3½ miles east of Gary Harbor, seven-eighths mile east of a north and south road to Miller, on the summit of a hill, 40 or 50 feet above the surface of the lake, and 200 meters (220 yards) from the water's edge. The station is marked by a 30-penny nail in a concrete block 6 by 6 by 36 inches set so that the top projects 1 inch above the surface. The top of the monument is marked "U. S. 1908."

Gary (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—About three-fourths mile east of Gary Harbor, 8 miles east of Indiana Harbor, on the top of a sand mound about 10 or 15 feet above the surface of the lake, and about 100 meters (110 yards) from the water's edge. The station is marked by a 30-penny nail in a concrete block 6 by 6 by 36 inches set so that the top projects 1 inch above the surface. The top of the monument is marked "U. S. 1908."

Stockton (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—About 4 miles northwest of Gary Harbor, 3½ miles southeast of Indiana Harbor, 1½ miles southeast of the Universal Cement Co. plant, 185 meters west of the north end of the north-and-south road to Clarke station on the Pennsylvania Railroad, 40 yards from the water's edge, and 9 feet above the surface of the lake. The northwest corner of a hotel bears S. 60° 05′ E. distant 187 meters (615 feet). The station is marked by a 30-penny nail in the center of a concrete block, 6 by 6 by 36 inches, set in the ground so that the top projects 1 inch above the surface. The top is marked "U. S. 1908."

Indiana Harbor (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—At Indiana Harbor, on the west wall on which the ore-unloading conveyors run at the ore dock of the Inland Steel Co. The station is a copper bolt cemented in the center of the top of the wall 3 feet from the north end.

Wolf River (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—On the west side of the mouth of the Wolf River, 7.5 feet above the lake, 2¾ miles southeast of Calumet Harbor, Ill., 1⅝ miles northwest of Whiting, 1⅛ miles southeast of the point where the Illinois-Indiana State line enters Lake Michigan. The west side of Sheffield Pier, Roby, at the water's edge bears N. 74° 35′ E. distant 37 meters (121 feet), another point on the same pier in line with the Inland Steel Co. stack bears S. 52° 00′ E. distant 19.5 meters (64 feet), and a 12-inch willow tree about 15 feet north of the northwest corner of Camp Cueno bears N. 78° 36′ W. distant 165 meters (541 feet). The station is marked by a 30-penny nail in the center of the top of a block of concrete which is set with the top projecting 1 inch above the surface. The top of the monument is marked "U. S. 1908."

Calumet (U. S. L. S.) (Cook County, Ill., U. S. Lake Survey, 1908).—The station is the head of a 30-penny nail at the intersection of two rows of nails driven in the top and center of the Calumet Harbor Breakwater, 1180 meters (3870 feet) west of the angle in the same, 174 meters (571 feet) east of the shore end, and 358 meters (1175 feet) from the northeast corner of the dock on the south side of the north slip of the Illinois Steel Co.

St. John's Church, spire (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1874).—St. John's Church (Deutsche Evangelical), spire, is at the southwest corner of Franklin and Ninth Streets.

St. Paul's Church, spire (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908).—St. Paul's Church, spire (Deutsche Evangelical) is at the northeast corner of Franklin and Ninth Streets. It was built in 1876 and is of the same style of architecture as St. John's Church, but is larger and has the higher steeple.

Hanna stack (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908.—It is a very large, cylindrical, white-brick stack at the Hanna Line electric power house, in the east end of Michigan City.

East Pierhead light (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908).—It is the center of the tower of the light at the outer end of the east pier at Michigan City.

West Pierhead light (U. S. L. S.) (Laporte County, U. S. Lake Survey, 1908).—It is the center of the tower of the light at the outer end of the west pier at Michigan City.

Inland Steel Co., stack (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—The point located is the center of the furnace stack of the Inland Steel Co. plant at Indiana Harbor.

Glucose stack (U. S. L. S.) (Lake County, U. S. Lake Survey, 1908).—About 1⅝ miles northwest of Whiting, five-eighths mile southwest of the shore of Lake Michigan. The point located is the center of the large, cylindrical, white-brick stack of the glucose factory near the north end of Wolf Lake.

CONVERSION TABLES.

Lengths—Feet to meters (from 1 to 1000 units).

[Reduction factor: 1 foot=0.3048006096 meter.]

Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.
0	0.0	50	15.24003	100	30.48006	150	45.72009	200	60.96012
1	0.30480	1	15.54483	1	30.78486	1	46.02489	1	61.26492
2	0.60960	2	15.84963	2	31.08966	2	46.32969	2	61.56972
3	0.91440	3	16.15443	3	31.39446	3	46.63449	3	61.87452
4	1.21920	4	16.45923	4	31.69926	4	46.93929	4	62.17932
5	1.52400	5	16.76403	5	32.00406	5	47.24409	5	62.48412
6	1.82880	6	17.06883	6	32.30886	6	47.54890	6	62.78893
7	2.13360	7	17.37363	7	32.61367	7	47.85370	7	63.09373
8	2.43840	8	17.67844	8	32.91847	8	48.15850	8	63.39853
9	2.74321	9	17.98324	9	33.22327	9	48.46330	9	63.70333
10	3.04801	60	18.28804	110	33.52807	160	48.76810	210	64.00813
1	3.35281	1	18.59284	1	33.83287	1	49.07290	1	64.31293
2	3.65761	2	18.89764	2	34.13767	2	49.37770	2	64.61773
3	3.96241	3	19.20244	3	34.44247	3	49.68250	3	64.92253
4	4.26721	4	19.50724	4	34.74727	4	49.98730	4	65.22733
5	4.57201	5	19.81204	5	35.05207	5	50.29210	5	65.53213
6	4.87681	6	20.11684	6	35.35687	6	50.59690	6	65.83693
7	5.18161	7	20.42164	7	35.66167	7	50.90170	7	66.14173
8	5.48641	8	20.72644	8	35.96647	8	51.20650	8	66.44653
9	5.79121	9	21.03124	9	36.27127	9	51.51130	9	66.75133
20	6.09601	70	21.33604	120	36.57607	170	51.81610	220	67.05613
1	6.40081	1	21.64084	1	36.88087	1	52.12090	1	67.36093
2	6.70561	2	21.94564	2	37.18567	2	52.42570	2	67.66574
3	7.01041	3	22.25044	3	37.49047	3	52.73051	3	67.97054
4	7.31521	4	22.55525	4	37.79528	4	53.03531	4	68.27534
5	7.62002	5	22.86005	5	38.10008	5	53.34011	5	68.58014
6	7.92482	6	23.16485	6	38.40488	6	53.64491	6	68.88494
7	8.22962	7	23.46965	7	38.70968	7	53.94971	7	69.18974
8	8.53442	8	23.77445	8	39.01448	8	54.25451	8	69.49454
9	8.83922	9	24.07925	9	39.31928	9	54.55931	9	69.79934
30	9.14402	80	24.38405	130	39.62408	180	54.86411	230	70.10414
1	9.44882	1	24.68885	1	39.92888	1	55.16891	1	70.40894
2	9.75362	2	24.99365	2	40.23368	2	55.47371	2	70.71374
3	10.05842	3	25.29845	3	40.53848	3	55.77851	3	71.01854
4	10.36322	4	25.60325	4	40.84328	4	56.08331	4	71.32334
5	10.66802	5	25.90805	5	41.14808	5	56.38811	5	71.62814
6	10.97282	6	26.21285	6	41.45288	6	56.69291	6	71.93294
7	11.27762	7	26.51765	7	41.75768	7	56.99771	7	72.23774
8	11.58242	8	26.82245	8	42.06248	8	57.30251	8	72.54255
9	11.88722	9	27.12725	9	42.36728	9	57.60732	9	72.84735
40	12.19202	90	27.43205	140	42.67209	190	57.91212	240	73.15215
1	12.49682	1	27.73686	1	42.97689	1	58.21692	1	73.45695
2	12.80163	2	28.04166	2	43.28169	2	58.52172	2	73.76175
3	13.10643	3	28.34646	3	43.58649	3	58.82652	3	74.06655
4	13.41123	4	28.65126	4	43.89129	4	59.13132	4	74.37135
5	13.71603	5	28.95606	5	44.19609	5	59.43612	5	74.67615
6	14.02083	6	29.26086	6	44.50089	6	59.74092	6	74.98095
7	14.32563	7	29.56566	7	44.80569	7	60.04572	7	75.28575
8	14.63043	8	29.87046	8	45.11049	8	60.35052	8	75.59055
9	14.93523	9	30.17526	9	45.41529	9	60.65532	9	75.89535

Lengths—Feet to meters (from 1 to 1000 units)—Continued.

Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.
250	76.20015	300	91.44018	350	106.68021	400	121.92024	450	137.16027
1	76.50495	1	91.74498	1	106.98501	1	122.22504	1	137.46507
2	76.80975	2	92.04978	2	107.28981	2	122.52985	2	137.76988
3	77.11455	3	92.35458	3	107.59462	3	122.83465	3	138.07468
4	77.41935	4	92.65939	4	107.89942	4	123.13945	4	138.37948
5	77.72416	5	92.96419	5	108.20422	5	123.44425	5	138.68428
6	78.02896	6	93.26899	6	108.50902	6	123.74905	6	138.98908
7	78.33376	7	93.57379	7	108.81382	7	124.05385	7	139.29388
8	78.63856	8	93.87859	8	109.11862	8	124.35865	8	139.59868
9	78.94336	9	94.18339	9	109.42342	9	124.66345	9	139.90348
260	79.24816	310	94.48819	360	109.72822	410	124.96825	460	140.20828
1	79.55296	1	94.79299	1	110.03302	1	125.27305	1	140.51308
2	79.85776	2	95.09779	2	110.33782	2	125.57785	2	140.81788
3	80.16256	3	95.40259	3	110.64262	3	125.88265	3	141.12268
4	80.46736	4	95.70739	4	110.94742	4	126.18745	4	141.42748
5	80.77216	5	96.01219	5	111.25222	5	126.49225	5	141.73228
6	81.07696	6	96.31699	6	111.55702	6	126.79705	6	142.03708
7	81.38176	7	96.62179	7	111.86182	7	127.10185	7	142.34188
8	81.68656	8	96.92659	8	112.16662	8	127.40665	8	142.64669
9	81.99136	9	97.23139	9	112.47142	9	127.71146	9	142.95149
270	82.29616	320	97.53620	370	112.77623	420	128.01626	470	143.25629
1	82.60097	1	97.84100	1	113.08103	1	128.32106	1	143.56109
2	82.90577	2	98.14580	2	113.38583	2	128.62586	2	143.86589
3	83.21057	3	98.45060	3	113.69063	3	128.93066	3	144.17069
4	83.51537	4	98.75540	4	113.99543	4	129.23546	4	144.47549
5	83.82017	5	99.06020	5	114.30023	5	129.54026	5	144.78029
6	84.12497	6	99.36500	6	114.60503	6	129.84506	6	145.08509
7	84.42977	7	99.66980	7	114.90983	7	130.14986	7	145.38989
8	84.73457	8	99.97460	8	115.21463	8	130.45466	8	145.69469
9	85.03937	9	100.27940	9	115.51943	9	130.75946	9	145.99949
280	85.34417	330	100.58420	380	115.82423	430	131.06426	480	146.30429
1	85.64897	1	100.88900	1	116.12903	1	131.36906	1	146.60909
2	85.95377	2	101.19380	2	116.43383	2	131.67386	2	146.91389
3	86.25857	3	101.49860	3	116.73863	3	131.97866	3	147.21869
4	86.56337	4	101.80340	4	117.04343	4	132.28346	4	147.52350
5	86.86817	5	102.10820	5	117.34823	5	132.58827	5	147.82830
6	87.17297	6	102.41300	6	117.65304	6	132.89307	6	148.13310
7	87.47777	7	102.71781	7	117.95784	7	133.19787	7	148.43790
8	87.78258	8	103.02261	8	118.26264	8	133.50267	8	148.74270
9	88.08738	9	103.32741	9	118.56744	9	133.80747	9	149.04750
290	88.39218	340	103.63221	390	118.87224	440	134.11227	490	149.35230
1	88.69698	1	103.93701	1	119.17704	1	134.41707	1	149.65710
2	89.00178	2	104.24181	2	119.48184	2	134.72187	2	149.96190
3	89.30658	3	104.54661	3	119.78664	3	135.02667	3	150.26670
4	89.61138	4	104.85141	4	120.09144	4	135.33147	4	150.57150
5	89.91618	5	105.15621	5	120.39624	5	135.63627	5	150.87630
6	90.22098	6	105.46101	6	120.70104	6	135.94107	6	151.18110
7	90.52578	7	105.76581	7	121.00584	7	136.24587	7	151.48590
8	90.83058	8	106.07061	8	121.31064	8	136.55067	8	151.79070
9	91.13538	9	106.37541	9	121.61544	9	136.85547	9	152.09550

Lengths—Feet to meters (from 1 to 1000 units)—Continued.

Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.
500	152.40030	550	167.64034	600	182.88037	650	198.12040	700	213.36043
1	152.70511	1	167.94514	1	183.18517	1	198.42520	1	213.66523
2	153.00991	2	168.24994	2	183.48997	2	198.73000	2	213.97003
3	153.31471	3	168.55474	3	183.79477	3	199.03480	3	214.27483
4	153.61951	4	168.85954	4	184.09957	4	199.33960	4	214.57963
5	153.92431	5	169.16434	5	184.40437	5	199.64440	5	214.88443
6	154.22911	6	169.46914	6	184.70917	6	199.94920	6	215.18923
7	154.53391	7	169.77394	7	185.01397	7	200.25400	7	215.49403
8	154.83871	8	170.07874	8	185.31877	8	200.55880	8	215.79883
9	155.14351	9	170.38354	9	185.62357	9	200.86360	9	216.10363
510	155.44831	560	170.68834	610	185.92837	660	201.16840	710	216.40843
1	155.75311	1	170.99314	1	186.23317	1	201.47320	1	216.71323
2	156.05791	2	171.29794	2	186.53797	2	201.77800	2	217.01803
3	156.36271	3	171.60274	3	186.84277	3	202.08280	3	217.32283
4	156.66751	4	171.90754	4	187.14757	4	202.38760	4	217.62764
5	156.97231	5	172.21234	5	187.45237	5	202.69241	5	217.93244
6	157.27711	6	172.51715	6	187.75718	6	202.99721	6	218.23724
7	157.58192	7	172.82195	7	188.06198	7	203.30201	7	218.54204
8	157.88672	8	173.12675	8	188.36678	8	203.60681	8	218.84684
9	158.19152	9	173.43155	9	188.67158	9	203.91161	9	219.15164
520	158.49632	570	173.73635	620	188.97638	670	204.21641	720	219.45644
1	158.80112	1	174.04115	1	189.28118	1	204.52121	1	219.76124
2	159.10592	2	174.34595	2	189.58598	2	204.82601	2	220.06604
3	159.41072	3	174.65075	3	189.89078	3	205.13081	3	220.37084
4	159.71552	4	174.95555	4	190.19558	4	205.43561	4	220.67564
5	160.02032	5	175.26035	5	190.50038	5	205.74041	5	220.98044
6	160.32512	6	175.56515	6	190.80518	6	206.04521	6	221.28524
7	160.62992	7	175.86995	7	191.10998	7	206.35001	7	221.59004
8	160.93472	8	176.17475	8	191.41478	8	206.65481	8	221.89484
9	161.23952	9	176.47955	9	191.71958	9	206.95961	9	222.19964
530	161.54432	580	176.78435	630	192.02438	680	207.26441	730	222.50445
1	161.84912	1	177.08915	1	192.32918	1	207.56922	1	222.80925
2	162.15392	2	177.39395	2	192.63399	2	207.87402	2	223.11405
3	162.45872	3	177.69876	3	192.93879	3	208.17882	3	223.41885
4	162.76353	4	178.00356	4	193.24359	4	208.48362	4	223.72365
5	163.06833	5	178.30836	5	193.54839	5	208.78842	5	224.02845
6	163.37313	6	178.61316	6	193.85319	6	209.09322	6	224.33325
7	163.67793	7	178.91796	7	194.15799	7	209.39802	7	224.63805
8	163.98273	8	179.22276	8	194.46279	8	209.70282	8	224.94285
9	164.28753	9	179.52756	9	194.76759	9	210.00762	9	225.24765
540	164.59233	590	179.83236	640	195.07239	690	210.31242	740	225.55245
1	164.89713	1	180.13716	1	195.37719	1	210.61722	1	225.85725
2	165.20193	2	180.44196	2	195.68199	2	210.92202	2	226.16205
3	165.50673	3	180.74676	3	195.98679	3	211.22682	3	226.46685
4	165.81153	4	181.05156	4	196.29159	4	211.53162	4	226.77165
5	166.11633	5	181.35636	5	196.59639	5	211.83642	5	227.07645
6	166.42113	6	181.66116	6	196.90119	6	212.14122	6	227.38125
7	166.72593	7	181.96596	7	197.20599	7	212.44602	7	227.68606
8	167.03073	8	182.27076	8	197.51080	8	212.75083	8	227.99086
9	167.33553	9	182.57557	9	197.81560	9	213.05563	9	228.29566

Lengths—Feet to meters (from 1 to 1000 units)—Continued.

Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.
750	228.60046	800	243.84049	850	259.08052	900	274.32055	950	289.56058
1	228.90526	1	244.14529	1	259.38532	1	274.62535	1	289.86538
2	229.21006	2	244.45009	2	259.69012	2	274.93015	2	290.17018
3	229.51486	3	244.75489	3	259.99492	3	275.23495	3	290.47498
4	229.81966	4	245.05969	4	260.29972	4	275.53975	4	290.77978
5	230.12446	5	245.36449	5	260.60452	5	275.84455	5	291.08458
6	230.42926	6	245.66929	6	260.90932	6	276.14935	6	291.38938
7	230.73406	7	245.97409	7	261.21412	7	276.45415	7	291.69418
8	231.03886	8	246.27889	8	261.51892	8	276.75895	8	291.99898
9	231.34366	9	246.58369	9	261.82372	9	277.06375	9	292.30378
760	231.64846	810	246.88849	860	262.12852	910	277.36855	960	292.60859
1	231.95326	1	247.19329	1	262.43332	1	277.67336	1	292.91339
2	232.25806	2	247.49809	2	262.73813	2	277.97816	2	293.21819
3	232.56287	3	247.80290	3	263.04293	3	278.28296	3	293.52299
4	232.86767	4	248.10770	4	263.34773	4	278.58776	4	293.82779
5	233.17247	5	248.41250	5	263.65253	5	278.89256	5	294.13259
6	233.47727	6	248.71730	6	263.95733	6	279.19736	6	294.43739
7	233.78207	7	249.02210	7	264.26213	7	279.50216	7	294.74219
8	234.08687	8	249.32690	8	264.56693	8	279.80696	8	295.04699
9	234.39167	9	249.63170	9	264.87173	9	280.11176	9	295.35179
770	234.69647	820	249.93650	870	265.17653	920	280.41656	970	295.65659
1	235.00127	1	250.24130	1	265.48133	1	280.72136	1	295.96139
2	235.30607	2	250.54610	2	265.78613	2	281.02616	2	296.26619
3	235.61087	3	250.85090	3	266.09093	3	281.33096	3	296.57099
4	235.91567	4	251.15570	4	266.39573	4	281.63576	4	296.87579
5	236.22047	5	251.46050	5	266.70053	5	281.94056	5	297.18059
6	236.52527	6	251.76530	6	267.00533	6	282.24536	6	297.48539
7	236.83007	7	252.07010	7	267.31013	7	282.55017	7	297.79020
8	237.13487	8	252.37490	8	267.61494	8	282.85497	8	298.09500
9	237.43967	9	252.67971	9	267.91974	9	283.15977	9	298.39980
780	237.74448	830	252.98451	880	268.22454	930	283.46457	980	298.70460
1	238.04928	1	253.28931	1	268.52934	1	283.76937	1	299.00940
2	238.35408	2	253.59411	2	268.83414	2	284.07417	2	299.31420
3	238.65888	3	253.89891	3	269.13894	3	284.37897	3	299.61900
4	238.96368	4	254.20371	4	269.44374	4	284.68377	4	299.92380
5	239.26848	5	254.50851	5	269.74854	5	284.98857	5	300.22860
6	239.57328	6	254.81331	6	270.05334	6	285.29337	6	300.53340
7	239.87808	7	255.11811	7	270.35814	7	285.59817	7	300.83820
8	240.18288	8	255.42291	8	270.66294	8	285.90297	8	301.14300
9	240.48768	9	255.72771	9	270.96774	9	286.20777	9	301.44780
790	240.79248	840	256.03251	890	271.27254	940	286.51257	990	301.75260
1	241.09728	1	256.33731	1	271.57734	1	286.81737	1	302.05740
2	241.40208	2	256.64211	2	271.88214	2	287.12217	2	302.36220
3	241.70688	3	256.94691	3	272.18694	3	287.42697	3	302.66701
4	242.01168	4	257.25171	4	272.49174	4	287.73178	4	302.97181
5	242.31648	5	257.55652	5	272.79655	5	288.03658	5	303.27661
6	242.62129	6	257.86132	6	273.10135	6	288.34138	6	303.58141
7	242.92609	7	258.16612	7	273.40615	7	288.64618	7	303.88621
8	243.23089	8	258.47092	8	273.71095	8	288.95098	8	304.19101
9	243.53569	9	258.77572	9	274.01575	9	289.25578	9	304.49581

Lengths—Meters to feet (from 1 to 1000 units).

[Reduction factor: 1 meter=3.28083333 feet.]

Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.
0		50	164.04167	100	328.08333	150	492.12500	200	656.16667
1	3.28083	1	167.32250	1	331.36417	1	495.40583	1	659.44750
2	6.56167	2	170.60333	2	334.64500	2	498.68667	2	662.72833
3	9.84250	3	173.88417	3	337.92583	3	501.96750	3	666.00917
4	13.12333	4	177.16500	4	341.20667	4	505.24833	4	669.29000
5	16.40417	5	180.44583	5	344.48750	5	508.52917	5	672.57083
6	19.68500	6	183.72667	6	347.76833	6	511.81000	6	675.85167
7	22.96583	7	187.00750	7	351.04917	7	515.09083	7	679.13250
8	26.24667	8	190.28833	8	354.33000	8	518.37167	8	682.41333
9	29.52750	9	193.56917	9	357.61083	9	521.65250	9	685.69417
10	32.80833	60	196.85000	110	360.89167	160	524.93333	210	688.97500
1	36.08917	1	200.13083	1	364.17250	1	528.21417	1	692.25583
2	39.37000	2	203.41167	2	367.45333	2	531.49500	2	695.53667
3	42.65083	3	206.69250	3	370.73417	3	534.77583	3	698.81750
4	45.93167	4	209.97333	4	374.01500	4	538.05667	4	702.09833
5	49.21250	5	213.25417	5	377.29583	5	541.33750	5	705.37917
6	52.49333	6	216.53500	6	380.57667	6	544.61833	6	708.66000
7	55.77417	7	219.81583	7	383.85750	7	547.89917	7	711.94083
8	59.05500	8	223.09667	8	387.13833	8	551.18000	8	715.22167
9	62.33583	9	226.37750	9	390.41917	9	554.46083	9	718.50250
20	65.61667	70	229.65833	120	393.70000	170	557.74167	220	721.78333
1	68.89750	1	232.93917	1	396.98083	1	561.02250	1	725.06417
2	72.17833	2	236.22000	2	400.26167	2	564.30333	2	728.34500
3	75.45917	3	239.50083	3	403.54250	3	567.58417	3	731.62583
4	78.74000	4	242.78167	4	406.82333	4	570.86500	4	734.90667
5	82.02083	5	246.06250	5	410.10417	5	574.14583	5	738.18750
6	85.30167	6	249.34333	6	413.38500	6	577.42667	6	741.46833
7	88.58250	7	252.62417	7	416.66583	7	580.70750	7	744.74917
8	91.86333	8	255.90500	8	419.94667	8	583.98833	8	748.03000
9	95.14417	9	259.18583	9	423.22750	9	587.26917	9	751.31083
30	98.42500	80	262.46667	130	426.50833	180	590.55000	230	754.59167
1	101.70583	1	265.74750	1	429.78917	1	593.83083	1	757.87250
2	104.98667	2	269.02833	2	433.07000	2	597.11167	2	761.15333
3	108.26750	3	272.30917	3	436.35083	3	600.39250	3	764.43417
4	111.54833	4	275.59000	4	439.63167	4	603.67333	4	767.71500
5	114.82917	5	278.87083	5	442.91250	5	606.95417	5	770.99583
6	118.11000	6	282.15167	6	446.19333	6	610.23500	6	774.27667
7	121.39083	7	285.43250	7	449.47417	7	613.51583	7	777.55750
8	124.67167	8	288.71333	8	452.75500	8	616.79667	8	780.83833
9	127.95250	9	291.99417	9	456.03583	9	620.07750	9	784.11917
40	131.23333	90	295.27500	140	459.31667	190	623.35833	240	787.40000
1	134.51417	1	298.55583	1	462.59750	1	626.63917	1	790.68083
2	137.79500	2	301.83667	2	465.87833	2	629.92000	2	793.96167
3	141.07583	3	305.11750	3	469.15917	3	633.20083	3	797.24250
4	144.35667	4	308.39833	4	472.44000	4	636.48167	4	800.52333
5	147.63750	5	311.67917	5	475.72083	5	639.76250	5	803.80417
6	150.91833	6	314.96000	6	479.00167	6	643.04333	6	807.08500
7	154.19917	7	318.24083	7	482.28250	7	646.32417	7	810.36583
8	157.48000	8	321.52167	8	485.56333	8	649.60500	8	813.64667
9	160.76083	9	324.80250	9	488.84417	9	652.88583	9	816.92750

Lengths—Meters to feet (from 1 to 1000 units)—Continued.

Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.
250	820.20833	300	984.25000	350	1,148.29167	400	1,312.33333	450	1,476.37500
1	823.49917	1	987.53083	1	1,151.57250	1	1,315.61417	1	1,479.65583
2	826.77000	2	990.81167	2	1,154.85333	2	1,318.89500	2	1,482.93667
3	830.05083	3	994.09250	3	1,158.13417	3	1,322.17583	3	1,486.21750
4	833.33167	4	997.37333	4	1,161.41500	4	1,325.45667	4	1,489.49833
5	836.61250	5	1,000.65417	5	1,164.69583	5	1,328.73750	5	1,492.77917
6	839.89333	6	1,003.93500	6	1,167.97667	6	1,332.01833	6	1,496.06000
7	843.17417	7	1,007.21583	7	1,171.25750	7	1,335.29917	7	1,499.34083
8	846.45500	8	1,010.49667	8	1,174.53833	8	1,338.58000	8	1,502.62167
9	849.73583	9	1,013.77750	9	1,177.81917	9	1,341.86083	9	1,505.90250
260	853.01667	310	1,017.05833	360	1,181.10000	410	1,345.14167	460	1,509.18333
1	856.29750	1	1,020.33917	1	1,184.38083	1	1,348.42250	1	1,512.46417
2	859.57833	2	1,023.62000	2	1,187.66167	2	1,351.70333	2	1,515.74500
3	862.85917	3	1,026.90083	3	1,190.94250	3	1,354.98417	3	1,519.02583
4	866.14000	4	1,030.18167	4	1,194.22333	4	1,358.26500	4	1,522.30667
5	869.42083	5	1,033.46250	5	1,197.50417	5	1,361.54583	5	1,525.58750
6	872.70167	6	1,036.74333	6	1,200.78500	6	1,364.82667	6	1,528.86833
7	875.98250	7	1,040.02417	7	1,204.06583	7	1,368.10750	7	1,532.14917
8	879.26333	8	1,043.30500	8	1,207.34667	8	1,371.38833	8	1,535.43000
9	882.54417	9	1,046.58583	9	1,210.62750	9	1,374.66917	9	1,538.71083
270	885.82500	320	1,049.86667	370	1,213.90833	420	1,377.95000	470	1,541.99167
1	889.10583	1	1,053.14750	1	1,217.18917	1	1,381.23083	1	1,545.27250
2	892.38667	2	1,056.42833	2	1,220.47000	2	1,384.51167	2	1,548.55333
3	895.66750	3	1,059.70917	3	1,223.75083	3	1,387.79250	3	1,551.83417
4	898.94833	4	1,062.99000	4	1,227.03167	4	1,391.07333	4	1,555.11500
5	902.22917	5	1,066.27083	5	1,230.31250	5	1,394.35417	5	1,558.39583
6	905.51000	6	1,069.55167	6	1,233.59333	6	1,397.63500	6	1,561.67667
7	908.79083	7	1,072.83250	7	1,236.87417	7	1,400.91583	7	1,564.95750
8	912.07167	8	1,076.11333	8	1,240.15500	8	1,404.19667	8	1,568.23833
9	915.35250	9	1,079.39417	9	1,243.43583	9	1,407.47750	9	1,571.51917
280	918.63333	330	1,082.67500	380	1,246.71667	430	1,410.75833	480	1,574.80000
1	921.91417	1	1,085.95583	1	1,249.99750	1	1,414.03917	1	1,578.08083
2	925.19500	2	1,089.23667	2	1,253.27833	2	1,417.32000	2	1,581.36167
3	928.47583	3	1,092.51750	3	1,256.55917	3	1,420.60083	3	1,584.64250
4	931.75667	4	1,095.79833	4	1,259.84000	4	1,423.88167	4	1,587.92333
5	935.03750	5	1,099.07917	5	1,263.12083	5	1,427.16250	5	1,591.20417
6	938.31833	6	1,102.36000	6	1,266.40167	6	1,430.44333	6	1,594.48500
7	941.59917	7	1,105.64083	7	1,269.68250	7	1,433.72417	7	1,597.76583
8	944.88000	8	1,108.92167	8	1,272.96333	8	1,437.00500	8	1,601.04667
9	948.16083	9	1,112.20250	9	1,276.24417	9	1,440.28583	9	1,604.32750
290	951.44167	340	1,115.48333	390	1,279.52500	440	1,443.56667	490	1,607.60833
1	954.72250	1	1,118.76417	1	1,282.80583	1	1,446.84750	1	1,610.88917
2	958.00333	2	1,122.04500	2	1,286.08667	2	1,450.12833	2	1,614.17000
3	961.28417	3	1,125.32583	3	1,289.36750	3	1,453.40917	3	1,617.45083
4	964.56500	4	1,128.60667	4	1,292.64833	4	1,456.69000	4	1,620.73167
5	967.84583	5	1,131.88750	5	1,295.92917	5	1,459.97083	5	1,624.01250
6	971.12667	6	1,135.16833	6	1,299.21000	6	1,463.25167	6	1,627.29333
7	974.40750	7	1,138.44917	7	1,302.49083	7	1,466.53250	7	1,630.57417
8	977.68833	8	1,141.73000	8	1,305.77167	8	1,469.81333	8	1,633.85500
9	980.96917	9	1,145.01083	9	1,309.05250	9	1,473.09417	9	1,637.13583

Lengths—Meters to feet (from 1 to 1000 units)—Continued.

Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.
500	1,640.41667	550	1,804.45833	600	1,968.50000	650	2,132.54167	700	2,296.58333
1	1,643.69750	1	1,807.73917	1	1,971.78083	1	2,135.82250	1	2,299.86417
2	1,646.97833	2	1,811.02000	2	1,975.06167	2	2,139.10333	2	2,303.14500
3	1,650.25917	3	1,814.30083	3	1,978.34250	3	2,142.38417	3	2,306.42583
4	1,653.54000	4	1,817.58167	4	1,981.62333	4	2,145.66500	4	2,309.70667
5	1,656.82083	5	1,820.86250	5	1,984.90417	5	2,148.94583	5	2,312.98750
6	1,660.10167	6	1,824.14333	6	1,988.18500	6	2,152.22667	6	2,316.26833
7	1,663.38250	7	1,827.42417	7	1,991.46583	7	2,155.50750	7	2,319.54917
8	1,666.66333	8	1,830.70500	8	1,994.74667	8	2,158.78833	8	2,322.83000
9	1,669.94417	9	1,833.98583	9	1,998.02750	9	2,162.06917	9	2,326.11083
510	1,673.22500	560	1,837.26667	610	2,001.30833	660	2,165.35000	710	2,329.39167
1	1,676.50583	1	1,840.54750	1	2,004.58917	1	2,168.63083	1	2,332.67250
2	1,679.78667	2	1,843.82833	2	2,007.87000	2	2,171.91167	2	2,335.95333
3	1,683.06750	3	1,847.10917	3	2,011.15083	3	2,175.19250	3	2,339.23417
4	1,686.34833	4	1,850.39000	4	2,014.43167	4	2,178.47333	4	2,342.51500
5	1,689.62917	5	1,853.67083	5	2,017.71250	5	2,181.75417	5	2,345.79583
6	1,692.91000	6	1,856.95167	6	2,020.99333	6	2,185.03500	6	2,349.07667
7	1,696.19083	7	1,860.23250	7	2,024.27417	7	2,188.31583	7	2,352.35750
8	1,699.47167	8	1,863.51333	8	2,027.55500	8	2,191.59667	8	2,355.63833
9	1,702.75250	9	1,866.79417	9	2,030.83583	9	2,194.87750	9	2,358.91917
520	1,706.03333	570	1,870.07500	620	2,034.11667	670	2,198.15833	720	2,362.20000
1	1,709.31417	1	1,873.35583	1	2,037.39750	1	2,201.43917	1	2,365.48083
2	1,712.59500	2	1,876.63667	2	2,040.67833	2	2,204.72000	2	2,368.76167
3	1,715.87583	3	1,879.91750	3	2,043.95917	3	2,208.00083	3	2,372.04250
4	1,719.15667	4	1,883.19833	4	2,047.24000	4	2,211.28167	4	2,375.32333
5	1,722.43750	5	1,886.47917	5	2,050.52083	5	2,214.56250	5	2,378.60417
6	1,725.71833	6	1,889.76000	6	2,053.80167	6	2,217.84333	6	2,381.88500
7	1,728.99917	7	1,893.04083	7	2,057.08250	7	2,221.12417	7	2,385.16583
8	1,732.28000	8	1,896.32167	8	2,060.36333	8	2,224.40500	8	2,388.44667
9	1,735.56083	9	1,899.60250	9	2,063.64417	9	2,227.68583	9	2,391.72750
530	1,738.84167	580	1,902.88333	630	2,066.92500	680	2,230.96667	730	2,395.00833
1	1,742.12250	1	1,906.16417	1	2,070.20583	1	2,234.24750	1	2,398.28917
2	1,745.40333	2	1,909.44500	2	2,073.48667	2	2,237.52833	2	2,401.57000
3	1,748.68417	3	1,912.72583	3	2,076.76750	3	2,240.80917	3	2,404.85083
4	1,751.96500	4	1,916.00667	4	2,080.04833	4	2,244.09000	4	2,408.13167
5	1,755.24583	5	1,919.28750	5	2,083.32917	5	2,247.37083	5	2,411.41250
6	1,758.52667	6	1,922.56833	6	2,086.61000	6	2,250.65167	6	2,414.69333
7	1,761.80750	7	1,925.84917	7	2,089.89083	7	2,253.93250	7	2,417.97417
8	1,765.08833	8	1,929.13000	8	2,093.17167	8	2,257.21333	8	2,421.25500
9	1,768.36917	9	1,932.41083	9	2,096.45250	9	2,260.49417	9	2,424.53583
540	1,771.65000	590	1,935.69167	640	2,099.73333	690	2,263.77500	740	2,427.81667
1	1,774.93083	1	1,938.97250	1	2,103 01417	1	2,267.05583	1	2,431.09750
2	1,778.21167	2	1,942.25333	2	2,106.29500	2	2,270.33667	2	2,434.37833
3	1,781.49250	3	1,945.53417	3	2,109.57583	3	2,273.61750	3	2,437.65917
4	1,784.77333	4	1,948.81500	4	2,112.85667	4	2,276.89833	4	2,440.94000
5	1,788.05417	5	1,952.09583	5	2,116.13750	5	2,280.17917	5	2,444.22083
6	1,791.33500	6	1,955.37667	6	2,119.41833	6	2,283.46000	6	2,447.50167
7	1,794.61583	7	1,958.65750	7	2,122.69917	7	2,286.74083	7	2,450.78250
8	1,797.89667	8	1,961.93833	8	2,125.98000	8	2,290.02167	8	2,454.06333
9	1,801.17750	9	1,965.21917	9	2,129.26083	9	2,293.30250	9	2,457.34417

Lengths—Meters to feet (from 1 to 1000 units)—Continued.

Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.
750	2,460.62500	800	2,624.66667	850	2,788.70833	900	2,952.75000	950	3,116.79167
1	2,463.90583	1	2,627.94750	1	2,791.98917	1	2,956.03083	1	3,120.07250
2	2,467.18667	2	2,631.22833	2	2,795.27000	2	2,959.31167	2	3,123.35333
3	2,470.46750	3	2,634.50917	3	2,798.55083	3	2,962.59250	3	3,126.63417
4	2,473.74833	4	2,637.79000	4	2,801.83167	4	2,965.87333	4	3,129.91500
5	2,477.02917	5	2,641.07083	5	2,805.11250	5	2,969.15417	5	3,133.19583
6	2,480.31000	6	2,644.35167	6	2,808.39333	6	2,972.43500	6	3,136.47667
7	2,483.59083	7	2,647.63250	7	2,811.67417	7	2,975.71583	7	3,139.75750
8	2,486.87167	8	2,650.91333	8	2,814.95500	8	2,978.99667	8	3,143.03833
9	2,490.15250	9	2,654.19417	9	2,818.23583	9	2,982.27750	9	3,146.31917
760	2,493.43333	810	2,657.47500	860	2,821.51667	910	2,985.55833	960	3,149.60000
1	2,496.71417	1	2,660.75583	1	2,824.79750	1	2,988.83917	1	3,152.88083
2	2,499.99500	2	2,664.03667	2	2,828.07833	2	2,992.12000	2	3,156.16167
3	2,503.27583	3	2,667.31750	3	2,831.35917	3	2,995.40083	3	3,159.44250
4	2,506.55667	4	2,670.59833	4	2,834.64000	4	2,998.68167	4	3,162.72333
5	2,509.83750	5	2,673.87917	5	2,837.92083	5	3,001.96250	5	3,166.00417
6	2,513.11833	6	2,677.16000	6	2,841.20167	6	3,005.24333	6	3,169.28500
7	2,516.39917	7	2,680.44083	7	2,844.48250	7	3,008.52417	7	3,172.56583
8	2,519.68000	8	2,683.72167	8	2,847.76333	8	3,011.80500	8	3,175.84667
9	2,522.96083	9	2,687.00250	9	2,851.04417	9	3,015.08583	9	3,179.12750
770	2,526.24167	820	2,690.28333	870	2,854.32500	920	3,018.36667	970	3,182.40833
1	2,529.52250	1	2,693.56417	1	2,857.60583	1	3,021.64750	1	3,185.68917
2	2,532.80333	2	2,696.84500	2	2,860.88667	2	3,024.92833	2	3,188.97000
3	2,536.08417	3	2,700.12583	3	2,864.16750	3	3,028.20917	3	3,192.25083
4	2,539.36500	4	2,703.40667	4	2,867.44833	4	3,031.49000	4	3,195.53167
5	2,542.64583	5	2,706.68750	5	2,870.72917	5	3,034.77083	5	3,198.81250
6	2,545.92667	6	2,709.96833	6	2,874.01000	6	3,038.05167	6	3,202.09333
7	2,549.20750	7	2,713.24917	7	2,877.29083	7	3,041.33250	7	3,205.37417
8	2,552.48833	8	2,716.53000	8	2,880.57167	8	3,044.61333	8	3,208.65500
9	2,555.76917	9	2,719.81083	9	2,883.85250	9	3,047.89417	9	3,211.93583
780	2,559.05000	830	2,723.09167	880	2,887.13333	930	3,051.17500	980	3,215.21667
1	2,562.33083	1	2,726.37250	1	2,890.41417	1	3,054.45583	1	3,218.49750
2	2,565.61167	2	2,729.65333	2	2,893.69500	2	3,057.73667	2	3,221.77833
3	2,568.89250	3	2,732.93417	3	2,896.97583	3	3,061.01750	3	3,225.05917
4	2,572.17333	4	2,736.21500	4	2,900.25667	4	3,064.29833	4	3,228.34000
5	2,575.45417	5	2,739.49583	5	2,903.53750	5	3,067.57917	5	3,231.62083
6	2,578.73500	6	2,742.77667	6	2,906.81833	6	3,070.86000	6	3,234.90167
7	2,582.01583	7	2,746.05750	7	2,910.09917	7	3,074.14083	7	3,238.18250
8	2,585.29667	8	2,749.33833	8	2,913.38000	8	3,077.42167	8	3,241.46333
9	2,588.57750	9	2,752.61917	9	2,916.66083	9	3,080.70250	9	3,244.74417
790	2,591.85833	840	2,755.90000	890	2,919.94167	940	3,083.98333	990	3,248.02500
1	2,595.13917	1	2,759.18083	1	2,923.22250	1	2,087.26417	1	3,251.30583
2	2,598.42000	2	2,762.46167	2	2,926.50333	2	3,090.54500	2	3,254.58667
3	2,601.70083	3	2,765.74250	3	2,929.78417	3	3,093.82583	3	3,257.86750
4	2,604.98167	4	2,769.02333	4	2,933.06500	4	3,097.10667	4	3,261.14833
5	2,608.26250	5	2,772.30417	5	2,936.34583	5	3,100.38750	5	3,264.42917
6	2,611.54333	6	2,775.58500	6	2,939.62667	6	3,103.66833	6	3,267.71000
7	2,614.82417	7	2,778.86583	7	2,942.90750	7	3,106.94917	7	3,270.99083
8	2,618.10500	8	2,782.14667	8	2,946.18833	8	3,110.23000	8	3,274.27167
9	2,621.38583	9	2,785.42750	9	2,949.46917	9	3,113.51083	9	3,277.55250

PART II.

GENERAL STATEMENT.

The triangulation across the southern part of Indiana is a part of the transcontinental arc of precise triangulation, and the field and office methods concerning it have already been fully discussed in Special Publication No. 4, of this Bureau. The triangulation along the northern boundary of Indiana is by the U. S. Lake Survey. The main scheme is of precise accuracy and it has been discussed in Appendix EEE, Report of the Chief of Engineers for 1902, and in Professional Papers, Corps of Engineers, U. S. Army, 1882. There remains then only the precise traverse which is entirely new. Enough description of the field and office methods used on this traverse is given in this publication to enable anyone interested to find out exactly what was done.

Precise traverse has come into extended use only within the last few years and its development has been simply a matter of economy. Due to the increase in the cost of labor, and lumber and other material since 1914, the cost of triangulation increased to such an extent that it became necessary to make use of precise traverse. Many changes and improvements have been made from time to time until now standard methods of operation, both in the field and office, seem to have been reached. The traverse usually follows closely the railroad right of way, though no doubt in the near future it will be advisable to use improved highways, as was done on this line of traverse in the vicinity of Indianapolis.

COST OF THE FIELD WORK.

The Indiana traverse cost $10 600, which amount includes all salaries, the transportation of men and instruments to the field, a fair depreciation on the trucks used, and all other field expenses. The length of the traverse was almost exactly 215 miles, making the cost per mile of progress a little less than $50. Geographic positions were determined for 166 marked points, at an average cost of about $64 per station.

In 1913 an arc of precise triangulation was executed over a section of country having somewhat the same topography as Indiana and where it was necessary to build tall signals at almost every station, as would have been the case in Indiana if triangulation had been used. Using the cost of this triangulation as a basis and taking into account the increased cost of labor and materials since 1913, it is estimated that it would have cost $98 per mile of progress had triangulation instead of traverse been used in Indiana. Also the triangulation would probably have located less than half as many marked stations, and these would not have been easily available for use on account of the necessary building.

ORGANIZATION OF THE PARTY.

After the party was fully organized it was divided into two sections. The first section did the reconnaissance, marked the stations, built

the signals, observed all the angles used for carrying ahead the azimuth, and observed the astronomic azimuths at about every 12 main stations. The second section measured all the distances and observed the angles at the subsidiary stations and determined the levels for the grade corrections.

RECONNAISSANCE, SIGNAL BUILDING, AND OBSERVING.

The party making the reconnaissance, building the signals, and observing the horizontal angles, usually called the observing party, consisted of Mr. Bilby, chief of party, an extra observer, a recorder, a foreman, and about three hands. The stations were located by the chief of party, and were marked and prepared for observing under his direction. Usually all that was necessary in the way of a signal was the tripod used for supporting the instrument, though at a few stations supports for the instrument and observing scaffolds from 18 to 30 feet high were required.

In making reconnaissance for the location of traverse stations several objects must be kept in view. The stations must be intervisible with the smallest possible amount of building; the line of sight must not pass near any object which will cause lateral refraction; the stations must be so located that the distance between them may be taped economically and rapidly; and, finally, they should be so placed as to be available for use by any local engineer. Frequently at curves the best location is at the point of intersection of the tangents, though this is often prohibited by the local topography or by structures. On tangents the stations are alternated, wherever possible, from one side of the right of way to the other, thus avoiding, in a great measure, the effects of lateral refraction caused by having the line of sight closely tangent to the track which becomes more heated by the sun than does the ground on either side of it. When the stations are thus alternated, any improvement, such as an additional track or siding, taking place on one side of the right of way will not disturb all the stations.

For the angle measurements and azimuth observations a 12-inch direction theodolite was usually used. This is the same instrument which has been in use for many years on precise triangulation and has been described and illustrated in several publications of this Bureau. At some of the stations an 8-inch direction instrument was used. This instrument has but two micrometer microscopes and consequently the number of positions observed was increased from 8 to 12 when it was used.

All observations for horizontal angles were made in the early morning, late afternoon, or at night. It was impossible to make observations of the required accuracy during the middle of the day, except on cloudy days. Conditions are probably more unfavorable for observing horizontal angles with high accuracy along a railroad right of way than in any other place where it has ever been attempted to observe them. The lines are almost always close to the ground, and frequently pass close to embankments, buildings, poles, or trees, any of which may and frequently do cause lateral refraction.

The reconnaissance and signal building was started at North Vernon on April 16, 1920, and carried ahead until June 7, when the

party moved back to North Vernon to organize and start the taping party. The observing of the horizontal angles was started on May 7 and continued until June 9, when this party also moved back to the starting point, and Mr. Mourhess, who had been doing the observing, took charge of the taping and continued with it until the finish of the line at South Bend.

As soon as the taping party was organized and well under way Mr. Bilby took a party and resumed the reconnaissance, signal building, and observing on June 23, 1920.

In all, 166 stations were occupied for horizontal angles. The observations at 63 of them were made by Mr. Mourhess, and at the remainder by E. C. States, extra observer. The observations were made in 59 days, thus giving an average of nearly 3 stations per day, a maximum of 10 stations was occupied on one day by Mr. States.

Since all operations were under one chief of party, and all accounts were submitted by him, it is almost impossible to separate the costs of the various operations, and no attempt has been made to do so.

ASTRONOMIC AZIMUTHS.

The greatest difficulty in traverse work of a high order of accuracy, when run along a railroad right of way, is to measure the horizontal angles with sufficient precision to hold the geodetic azimuths within the required limits. It is necessary to observe astronomic azimuths at short intervals in order that the geodetic azimuth may not deviate enough to cause inaccuracy in the geographic position greater than the allowable limit.

Azimuth was determined by observations on Polaris at any hour angle by the usual methods, except that the Naval Observatory time signals transmitted over the telegraph lines were used in place of time observations with the vertical circle. The results obtained were satisfactory. Observations were made on one night only at each station and always with the 12-inch instrument.

The following table shows the stations at which azimuths were observed, the station used as the mark, the date of observation, the astronomic azimuth and the probable error.

Stations.	Date.	Azimuth.	Probable error.
	1920	° ′ ″	″
Tripp to Adams	May 9,13	183 40 09.28	±0.47
Clay to Clark	May 18	149 45 17.28	±0.41
Dubois to Delaware	May 21	310 36 17.68	±0.47
Sherman to Elevator	June 28	179 30 10.34	±0.39
Western to Gibson	June 24	221 37 06.12	±0.26
Hancock to Harrison	June 7	179 45 20.52	±0.59
Henry to Cicero	June 25	186 05 00.95	±0.51
Jackson to New Hope	July 9	159 11 15.63	±0.61
Cassedy to Shope	July 11	153 04 35.30	±0.34
Leonda to Vandalia	July 17	82 36 07.89	±0.51
Boon to Montgomery	July 19	179 47 57.68	±0.43
Porter to Posey	July 23	177 46 55.20	±0.43
Joseph to Twin	July 27	36 43 49.64	±0.44
Aman to States	Aug. 3	192 08 39.38	±0.32
Penn to South Bend east base	Aug. 2	207 00 22.23	±0.38
Mean			±0.44

DIFFERENCE BETWEEN THE ASTRONOMIC AND GEODETIC AZIMUTHS.

Before the field work was started a study was made of the probable deflections in the prime vertical which might be expected in the region through which the traverse was to run. The six nearest stations of the U. S. Lake Survey and the thirty-ninth parallel triangulation, at which both astronomic and geodetic longitudes were known, were used in this investigation. Since the topography of Indiana and the surrounding country is very flat, no great difference was anticipated between the astronomic and geodetic azimuths along the traverse. The data in the following table seemed to bear this out to such an extent that the astronomic azimuths were held fixed without correction.

From the Laplace equation the geodetic azimuth can be computed when the geodetic latitude and longitude, the astronomic longitude, and astronomic azimuth of a single station, are known, thus

$$\alpha_G = \alpha_A + \sin\varphi\,(\lambda_A - \lambda_G)$$

where α_G is the geodetic azimuth, α_A the astronomic azimuth, φ the geodetic latitude, λ_A the astronomic longitude, and λ_G the geodetic longitude.

The table following gives the geodetic positions of the points considered, with the seconds of the astronomic longitude, followed by the astronomic minus the geodetic longitude, and in the last column the astronomic minus the geodetic longitude multiplied by the sine of the geodetic latitude. Each value in the last column is the amount to be added algebraically to the astronomic azimuth at that station to produce the geodetic azimuth. It will be noticed that in every case this amount is so small as to cause no appreciable error if neglected in the computations. The astronomic azimuths were therefore held fixed along this arc, thus making a considerable saving by avoiding the necessity of determining several longitude differences.

Station.	Latitude, geodetic.	Longitude.		Astronomic—geodetic longitude ($\lambda_A - \lambda_G$).	($\lambda_A - \lambda_G$) sin φ.
		Geodetic.	Astronomic.		
	° ′ ″	° ′ ″	″	″	″
Monroe	41 54 52.44	83 23 48.93	45.69	−3.24	−2.16
Willow Springs	41 43 36.90	87 51 05.63	06.09	+0.46	+0.31
Parkersburg	38 34 53.20	88 01 49.00	48.30	−0.70	−0.44
Vincennes	38 40 35.70	87 31 35.05	34.14	−4.91	−3.07
Louisville	38 15 06.79	85 45 31.82	30.85	−0.97	−0.60
O. & M.	38 29 00.28	85 40 11.50	11.69	+0.19	+0.12

TAPE MEASUREMENTS.

The taping party was organized at North Vernon on June 9, 1920. From that date until the line was finished at South Bend on August 11, the taping was as continuous as the weather would permit. The average progress was at the rate of 108 miles of completed line per month.

The ideal condition for taping on precise traverse is a straight and level track between the two points which the traverse connects. This condition, of course, does not exist, as curves and changes of

Fig. 2.—MOVING THE TAPE FORWARD.

The tape is carried free from the ground and never allowed to drag.

Fig. 3.—PLACING THE TAPE ON THE RAIL.

As the tension is applied the man at the middle of the tape lowers it gradually to the rail.

Fig. 4.—THE FORWARD END OF THE TAPE AND THE RECORDER.

Marking the end of the tape on the rail with a glass cutter.

Fig. 5.—THE REAR END OF THE TAPE.

Making the mark on the rear end of the tape coincident with the mark on the rail.

elevation are constantly encountered. In Indiana the conditions were probably about the average that will be found in country where it is advantageous to use precise traverse in preference to triangulation. Through several large towns and cities the line left the railroad and ran over improved highways and streets, thus avoiding the railroad yards with the heavy traffic and curves which make traverse most difficult in the vicinity of cities if an attempt is made to stay on the railroad right of way.

Transportation throughout the season was by means of motor trucks, which proved very satisfactory, since there are highways along nearly every section line, and frequently a trunk highway was parallel to the railroad or the railroad was immediately along a section line. One truck was always in close communication with the taping party, carrying instruments, extra tapes, thermometers, stakes, and in fact everything that would be needed for the taping under any condition which might arise.

TAPING ALONG THE RAIL.

Always, when possible, the measurements were made on the rail, the tape being supported throughout its length. The majority of the measurements were not made directly from one station to another, but from a point on the rail opposite one station to a point on the rail opposite the next station. The distance and angle from the point on the rail to the station were measured in each case, and the actual distance between the stations was computed from these data. In making the computations of traverse distances several different cases arise, depending on the locations of the stations with respect to the rail. These are fully explained in the "General instructions for precise and secondary traverse," U. S. Coast and Geodetic Survey, Special Publication, No. 58.

At curves the taping must leave the rail at the begining of the curve and be carried over stakes. Setting and aligning these stakes and running the necessary levels over them greatly retards the progress of the taping.

Another condition which frequently arises in traverse measurements is the impossibility of taping in a direct line between two main stations. For example, two main stations may be intervisible, each being on the railroad right of way and on elevated ground, but the intervening track may make several curves, and the topography directly in a line between the stations may be such as to prohibit economical traverse measurements along that line. What is done is to choose supplemental stations to give the best route and run a series of courses to connect the two main stations, measuring the necessary angles at the additional stations with a 7-inch repeating theodolite and the distances in the usual manner. All angles are measured in order to form a closed figure. From these data the lengths are projected onto the line between the two main stations.

In carrying precise traverse through cities and large towns it is almost necessary to leave the railroad and to follow the streets and highways. It seems advisable, therefore, to note here the methods used in taping over paved streets and improved highways.

In Indianapolis the route chosen was around the eastern side of the city to the Lake Erie & Western Railroad right of way north of

the city, a distance of 26.5 kilometers, all over improved streets. Seventeen main stations were located on or near the streets, and the angles at these were measured either in the early morning, by observing on heliographs, or late at night, by pointing on electric signal lamps. In this way good observing conditions were attained, and most of the heavy automobile traffic was avoided. An azimuth was observed at station Sherman, which is located on the concrete pavement of Sherman Drive, and though the instrument was mounted on a stand resting on the pavement and was not fastened or weighted down in any way, there was no noticeable disturbance caused by the passing of even heavy trucks. Sixteen positions of the theodolite circle were used. Three of these were rejected and those remaining gave a probable error of the azimuth of $\pm 0''.39$.

The same tape stretchers were used as for the taping on the rail, as they were easily adapted to this work by putting a piece of board between the flanges which fit over the rail, thus giving a flat surface against the pavement.

For marking the tape ends, adhesive tape 1 inch wide, such as can be purchased at any drug store, was used. A piece of this tape about 3 inches long was stuck to the pavement and the end of the tape was marked on it with a hard pencil. With a little practice the man making the forward contact was able to apply the adhesive tape quickly and in the proper place. Each tape end was numbered on the pavement with yellow lumber crayon so that it might be easily recovered by the rodman of the level party and by the party making the check measurement. It was found that this sort of mark lasted two or three days on the brick and concrete pavements, but much longer on the oil-bound macadam.

Where possible the line as taped was chosen so as to run near the curb, thus avoiding the traffic, and also for the very important reason that the curb line was sufficiently straight so that it was not necessary to use an instrument to maintain the line. A distance of about 1 foot inside the curb was found to be the most practical, for in addition to avoiding the traffic the wash of sand found close to the curb was also missed.

The difference in elevation of the tape ends was determined by wye levels, and the check measurement was made in the usual way with the 300-foot steel tape.

INSTRUMENTS USED IN CONNECTION WITH THE TAPING.

The invar tapes used for precise traverse are of the same type as those used for measuring bases of precise triangulation. They were standardized at the Bureau of Standards under a tension of 15 kilograms, when supported throughout, and also when supported at five points (0, 12½, 25, 37½ and 50 meter points), and at the three points (0, 25, and 50 meters). The coefficient of expansion is also determined. The standardization is accurate to at least one part in 300 000.

In compliance with instructions, no set-backs were measured but all distances less than a tape length were measured as set-ups with a 30-meter steel pocket tape. If the set-up was more than 25 meters, the mark at the middle of the invar tape was used in making part of the measurement. Recently the traverse tapes have been graduated

Fig. 6.—FILING A MARK ON THE RAIL AT THE END OF A KILOMETER.

Fig. 7.—THE TAPE STRETCHER AT A ROAD CROSSING.

This type of stretcher can be used readily on road crossings where the rails are practically flush with the highway.

Fig. 8.—TAPING ALONG THE SIDEWALK.

Fig. 9.—REELING UP THE TAPE.

for every 5 meters instead of at the ends only and the set-ups will not exceed 5 meters on future work.

The tension was maintained at 15 kilograms by means of a spring balance at the front end of the tape. The balance was tested daily. A thermometer near each end of the tape gave the necessary temperature readings.

The tape stretchers for applying the tension to the tape on top of the rail were made in the field by Mr. Bilby and gave excellent results. They were used not only in Indiana but for about 300 miles in Illinois and Wisconsin. Each stretcher consisted of a shoe of galvanized iron about 18 inches long and just wide enough to fit over the top of the rail. Uprights projected about 6 inches above the top of the rail, making a bearing for the lever. The tape was attached to the lower end of this lever by means of a hook which held the tape close to the rail while the tension was applied. The complete stretcher weighed only 2 or 3 pounds.

Wherever the taping was over stakes, wye levels were run to get the differences in elevation between the tape ends for use in computing the inclination corrections. When the measurement was made directly on the rail, "Experimental Track Sector No. 1" was used to determine the inclination of the tape. As the name indicates this instrument was built as an experiment but was found to be very satisfactory. It consists of a board about 6 feet long which rests on the rail at the points A, figure 10. A level bubble B, moved by a tangent screw T, is mounted at the middle of the board. By bringing the bubble to the center by means of the tangent screw and reading the vernier a determination of the inclination of the track is obtained. One such reading was made for each tape length measured on the track. The data thus obtained were found to be sufficiently accurate for the purpose of computing the grade corrections and much more rapidly and economically obtained than by running wye levels.

Previous to its use on the Indiana traverse the track sector was tested on a kilometer of traverse near Alexandria, La., by a traverse party just completing a season's work. The result showed the total inclination correction for the kilometer to be 0.2 millimeter less when computed from the sector data than when computed from the precise leveling data. In other words the difference in the results obtained by the two methods amounted to only 1 part in 5 000 000 of the total distance.

A new level, figure 11, has since been made, which involves the same principles, but is better adapted to the work. This instrument rests on the points designated as A, which are about 6 feet apart. The bubble B is mounted on a movable arm pivoted at P, to which is also attached a graduated arc and vernier at V. The movable arm is about 30 inches long and is not supplied with a clamp or slow-motion screw, but resists motion by friction only. The scale is graduated to 10′ with a vernier reading to minutes. By the use of the long arm the bubble can be centered very rapidly and about as accurately as with a short arm and a slow-motion screw, and the graduations are of such a size as to be quickly read. On the back of the board is a hinged leg which falls a short distance away from the board as it is leaned over and thus supports the sector while the operator records the observation.

The tape ends were marked on the rail by means of an ordinary glass cutter. This mark was indicated by a lumber crayon mark on the rail, and also by the number of the tape length which was marked on the nearest crosstie. The end of each kilometer and the point on the rail opposite each principal station was marked on the rail by filing a cross mark. This mark was made of such a depth as to insure its lasting until the check measurement had been made perhaps a week or 10 days later.

A check measurement of each traverse distance was made with a 300-foot steel tape. The object of this measurement was to catch errors or blunders of the order of magnitude of a 50-meter tape length, and consequently no attempt was made to secure a high order of accuracy. All set-ups on the precise measurement shorter than a half tape length were checked by being measured accurately in both meters and feet.

THE OFFICE COMPUTATION.

The office computation of a traverse includes the following operations: A thorough inspection and check of all record books; the computation and application to the measured lengths of all corrections due to standardization of tapes, temperature, inclination, and reduction to sea level; the projection of all measured lengths onto the lines between the stations; the computation of the closures of loops and of distances between the main stations; the computation of the preliminary geodetic positions; the least-squares adjustment; and, last, the computation of the final geodetic positions of the stations.

The office computation of the lengths was made under the direct supervision of W. D. Sutcliffe, mathematician; the astronomic azimuths were computed by Sarah Beall, mathematician; and the least-squares adjustment was made by Mr. Mourhess.

The office computation was made as prescribed in the "General Instructions for Precise and Secondary Traverse," U. S. Coast and Geodetic Survey Special Publication No. 58, with the exception of the inclination corrections for that part of the traverse which was measured on the rail, for which the inclination correction was computed for each tape length from the data obtained from the track level observations.

THE LEAST-SQUARES ADJUSTMENT.

The least-squares adjustment of a traverse must eliminate the discrepancies in azimuth, which are due mainly to errors in measuring the angles. These small errors in the angles cause a difference between the astronomic azimuth of a line and the azimuth of that same line as computed through the traverse from the preceding fixed azimuth. In the work under discussion the astronomic azimuths were held fixed without being corrected for the deflection of the plumb line, it being assumed that in this level topography the deflection is always small and of approximately the same size. (See p. 70). The adjustment must also eliminate the discrepancy in geographic position of the end point of the traverse. In this case the traverse started from a fixed position of the transcontinental triangula-

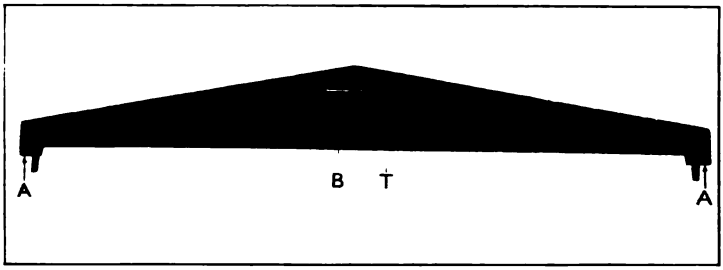

Fig. 10.—EXPERIMENTAL TRACK SECTOR NO. 1.

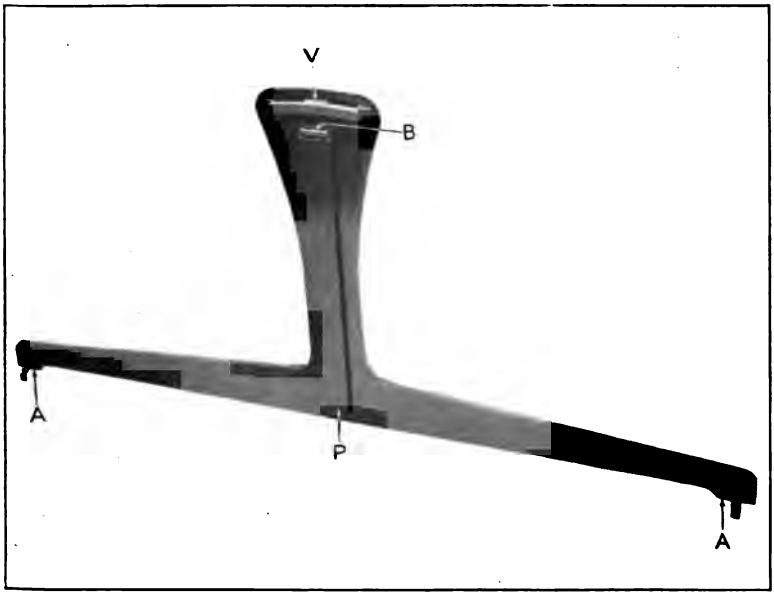

Fig. 11.—NEW MODEL TRACK LEVEL.

tion and ended on a station of the Lake Survey triangulation which was also fixed in position. The discrepancy to be eliminated was the difference between the fixed position of the final point and the position of the same point as computed through the traverse beginning with the transcontinental data. It should be remembered that in a traverse, unlike triangulation, there is no mathematical relation between the lengths of the courses and the angles between them.

The method used in the adjustment of the traverse was devised by the members of the division of geodesy as a practical means for the elimination of the discrepancies without too great an expenditure of time and labor A development of the method used is given below.

The corrections to the lengths are expressed in units of the sixth place of decimals of the logarithms, and the corrections to the angles are expressed as usual in seconds of angular measure. In order to hold what was considered a proper relation between the proportion of the discrepancy put on the lengths and the proportion put on the angles, a system of weighting was determined experimentally, satisfactory to the best judgment of the members of the division of geodesy. Since the completion of this adjustment another method has been devised which may be used in future adjustments of traverse.

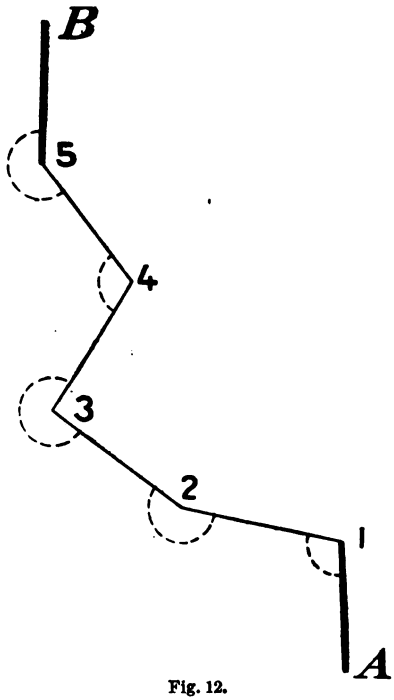

Fig. 12.

In considering the condition equations for the distribution of the latitude and longitude discrepancies, it must be remembered that they are developed from the changes which will occur in the formulae for the computation of geodetic positions due to small changes in length and azimuth. These formulae are given fully in U. S. Coast and Geodetic Survey Special Publication No. 8, entitled "Formulae and tables for the computation of geodetic positions."

The first term, and the only one here considered, of the formula for the difference of latitude, is

$$\Delta\varphi = -S \cos \alpha B, \tag{1}$$

and for the difference of longitude, is

$$\Delta\lambda = S \sin \alpha A' \sec \varphi', \tag{2}$$

where S is the distance between the points, α is the azimuth from the fixed to the new point, φ' is the latitude of the new point, and B and A' are factors depending on the latitude of the stations and the dimensions of the reference spheroid.

In figure No. 12 let 1 and 5 be fixed in both latitude and longitude and let the azimuths of the lines 1 to A and 5 to B be fixed. A traverse is run from 1 to 5, all distances and angles being measured. From the data thus obtained, the preliminary latitude and longitude of each point is computed, and also the preliminary azimuth of each line. Then there will be, of course, a small discrepancy between the fixed latitude and longitude of 5, the final point, and the latitude and longitude as derived from the computation.

Now let the computed latitude and longitude be represented by φ_1 and λ_1 for the first point, φ_2 and λ_2 for the second point, and so on to φ_n and λ_n for the final point. Let the length of the first course be represented by S_1, the second by S_2, and so on to S_n for the final course. Let V_{s_1} be the change in the logarithm of the distance S_1, V_{s_2} the change for S_2, and so on to V_{s_n} for S_n.

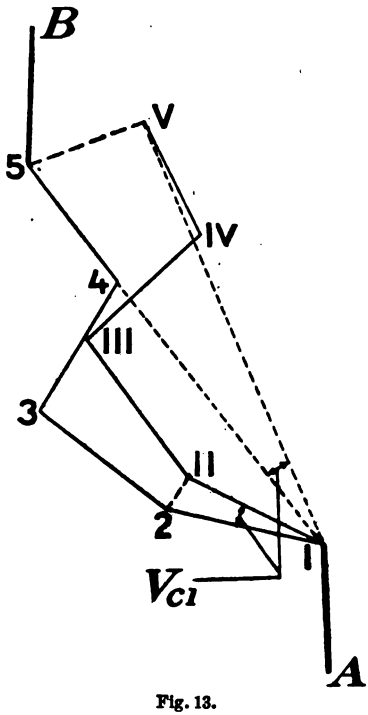

Fig. 13.

Knowing the number to which a given logarithm corresponds, the change in the number due to a *small* change in the logarithm, can be found by multiplying the number by the change in the logarithm and dividing by M, the modulus of the common system of logarithms.

Let us now consider the change in the first term of the latitude formula, equation (1), which will be brought about by a change in the distance S. If we take the first course of the traverse, that is from 1 to 2, where the change in the logarithm of the length is V_{s_1}, it is evident that the change in the logarithm of the first term will also be V_{s_1}. Now the number, corresponding to the first term of the latitude formula, may be expressed closely enough for this purpose by $\varphi_2 - \varphi_1$. If this be multiplied by V_{s_1} and divided by $10^6 M$ it will show in seconds of latitude the change caused by V_{s_1}. Ten to the sixth power is here introduced since the sixth place of the logarithm has been arbitrarily taken as the unit.

Then the change in latitude

$$= \frac{\varphi_2 - \varphi_1}{10^6 M} (V_{s_1}). \qquad (3)$$

In a similar way the change in longitude due to a cnange of V_{s_1} in the logarithm of the length S_1,

$$= \frac{\lambda_2 - \lambda_1}{10^6 M} (V_{s_1}) \qquad (4)$$

The change in the length of the line from 1 to 2 will affect the geodetic position of the final point by exactly the same amount as it affects the geodetic position of 2. Hence the effect on the geodetic position of the final point, of a change in each length, will be simply the sum of the individual changes of position caused by these length changes.

Next we must consider the effect on the geodetic position of 2, of a small change in the observed angle at 1, and also the effect of this change on the position of the final point.

Let Vc_1 be the small change in seconds in the observed angle at 1, Vc_2 the change in the angle at 2, etc.

Due to the small change Vc_1 the point 2 will rotate about 1 to some point II, figure No. 13. Then introducing arc 1″ to reduce to circular measure, the distance 2 to II $= S_1 Vc_1$ arc 1″.

Now let α = the azimuth of the line 1 to 2; then $90° + \alpha$ = the azimuth of the line 2 to II.

From the first term in the latitude formula, equation (1), the change in latitude due to a change Vc_1

$$= -S_1 Vc_1 \text{ arc } 1'' \cos (90° + \alpha) B_1$$

$$= + Vc_1 B_1 \text{ arc } 1'' S_1 \sin \alpha.$$

But from the longitude formula, equation (2),

$$\lambda_2 - \lambda_1 = S_1 \sin \alpha A' \sec \varphi'$$

or

$$S_1 \sin \alpha = \frac{\lambda_2 - \lambda_1}{A' \sec \varphi'}.$$

Or substituting above, the change in latitude due to Vc_1 may be expressed as

$$\frac{B_1 \text{ arc } 1''}{A_2 \sec \varphi_2} (\lambda_2 - \lambda_1) (Vc_1). \tag{5}$$

In equation (5) and thereafter the subscripts after B, A, and sec φ refer to the points (see fig. 13) upon the latitude of which these functions depend.

In the same manner a change in longitude due to the small change Vc_1 in the azimuth

$$= + S_1 Vc_1 \text{ arc } 1'' \sin (90° + \alpha) A_2 \sec \varphi_2,$$

$$= + S_1 Vc_1 \text{ arc } 1'' \cos \alpha A_2 \sec \varphi_2.$$

But from the latitude formula, equation (1), neglecting the small terms as before,

$$\varphi_2 - \varphi_1 = -S_1 \cos \alpha B_1,$$

or

$$S_1 \cos \alpha = -\frac{\varphi_2 - \varphi_1}{B_1}.$$

Or substituting this expression in the above equation, the change in longitude may be expressed as

$$= -\frac{A_2 \sec \varphi_2 \text{ arc } 1''}{B_1} (\varphi_2 - \varphi_1) (V_{c_1}). \qquad (6)$$

Now equations (5) and (6) represent the changes in latitude and longitude which take place in point 2 due to a small change in the azimuth, but a change in the azimuth of the first course affects the azimuth of each succeeding course, and consequently changes the geodetic position of each point on the traverse. The effect on the final point will be expressed by substituting $(\varphi_n - \varphi_1)$ for $(\varphi_2 - \varphi_1)$ and $(\lambda_n - \lambda_1)$ for $(\lambda_2 - \lambda_1)$.

Then the change in position of the final point due to the change in the length and azimuth of the first course will be, for the latitude, the sum of equations (3) and (5) or

$$\frac{\varphi_2 - \varphi_1}{10^6 M} (V_{s_1}) + \frac{B_1 \text{ arc } 1''}{A_n \sec \varphi_n} (\lambda_n - \lambda_1) (V_{c_1}),$$

and for the longitude, the sum of equations (4) and (6) or

$$\frac{\lambda_2 - \lambda_1}{10^6 M} (V_{s_1}) - \frac{A_2 \sec \varphi_2 \text{ arc } 1''}{B_1} (\varphi_n - \varphi_1) (V_{c_1}).$$

The change in the position of the final point for a change in the length and azimuth of each course may be determined in the same way. Then if $\varphi_{n'}$ and $\lambda_{n'}$ are the fixed latitude and longitude of the final point, the equation for the latitude will be

$$0 = (\varphi_n - \varphi_{n'}) + \left[\frac{\varphi_2 - \varphi_1}{10^6 M} (V_{s_1}) + \frac{\varphi_3 - \varphi_2}{10^6 M} (V_{s_2}) + \cdots \frac{\varphi_n - \varphi_{n-1}}{10^6 M} (V_{s_n})\right]$$

$$+ \left[\frac{B_1 \text{ arc } 1''}{A_n \sec \varphi_n} (\lambda_n - \lambda_1) (V_{c_1}) + \frac{B_2 \text{ arc } 1''}{A_n \sec \varphi_n} (\lambda_n - \lambda_2) (V_{c_2}) + \cdots\cdots\right.$$

$$\left. \frac{B_n \text{ arc } 1''}{A_n \sec \varphi_n} (\lambda_n - \lambda_{n-1}) (V_{c_n})\right]. \qquad (7)$$

For the longitude of the final point the equation will be

$$0 = (\lambda_n - \lambda_{n'}) + \left[\frac{\lambda_2 - \lambda_1}{10^6 M} (V_{s_1}) + \frac{\lambda_3 - \lambda_2}{10^6 M} (V_{s_2}) + \cdots \frac{\lambda_n - \lambda_{n-1}}{10^6 M} (V_{s_n})\right]$$

$$+ \left[-\frac{A_n \sec \varphi_n \text{ arc } 1''}{B_1} (\varphi_n - \varphi_1) (V_{c_1})\right.$$

$$- \frac{A_n \sec \varphi_n \text{ arc } 1''}{B_2} (\varphi_n - \varphi_2) (V_{c_2}) \cdots\cdots$$

$$\left. - \frac{A_n \sec \varphi_n \text{ arc } 1''}{B_n} (\varphi_n - \varphi_{n-1}) (V_{c_n})\right]. \qquad (8)$$

It is close enough to take the differences in latitude and longitude to minutes and decimals. If this is done the equations should be divided by 60, since as they now stand the differences in position are in seconds. The minute and second symbols after the parentheses in the following equations show whether the difference indicated within the parenthesis is expressed in minutes or seconds. Multiplying equations (7) and (8) by $10^6 M$ and changing from seconds to minutes, we have

$$0 = +\frac{10^6 M}{60}(\varphi_n - \varphi_{n'})'' + [(\varphi_2 - \varphi_1)'(V_{s_1}) + (\varphi_3 - \varphi_2)'(V_{s_2}) + \cdots$$

$$+ (\varphi_n - \varphi_{n-1})'(V_{s_n})] + 10^6 M\left[\frac{B_1 \text{ arc } 1''}{A_n \sec \varphi_n}(\lambda_n - \lambda_1)'(V_{c_1})\right.$$

$$+ \frac{B_2 \text{ arc } 1''}{A_n \sec \varphi_n}(\lambda_n - \lambda_2)'(V_{c_2}) + \cdots$$

$$\left. + \frac{B_n \text{ arc } 1''}{A_n \sec \varphi_n}(\lambda_n - \lambda_{n-1})'(V_{c_n})\right], \qquad (9)$$

and

$$0 = +\frac{10^6 M}{60}(\lambda_n - \lambda_{n'})'' + [(\lambda_2 - \lambda_1)'(V_{s_1}) + (\lambda_3 - \lambda_2)'(V_{s_2})$$

$$+ \cdots (\lambda_n - \lambda_{n-1})'(V_{s_n})] + 10^6 M\left[-\frac{A_n \sec \varphi_n \text{ arc } 1''}{B_1}(\varphi_n - \varphi_1)'(V_{c_1})\right.$$

$$- \frac{A_n \sec \varphi_n \text{ arc } 1''}{B_2}(\varphi_n - \varphi_2)'(V_{c_2}) - \cdots$$

$$\left. - \frac{A_n \sec \varphi_n \text{ arc } 1''}{B_n}(\varphi_n - \varphi_{n-1})'(V_{c_n})\right]. \qquad (10)$$

The following substitutions may be made in equations (9) and (10)

$$a_1 = +10^6 M \frac{B \text{ arc } 1''}{A_n \sec \varphi_n}$$

$$a_2 = -10^6 M \frac{A_n \sec \varphi_n \text{ arc } 1''}{B}$$

$$\frac{10^6 M}{60} = 7238.24.$$

The B factor changes so slowly for any traverse, that the mean latitude may be taken as an argument. The latitude of the final point is used as the argument for A_n and sec φ_n. The quantities designated as a_1 and a_2 may thus be computed and used as a constant for each of the terms affected.

The final latitude equation becomes

$$0 = +7238.24(\varphi_n - \varphi_{n'})'' + [(\varphi_2 - \varphi_1)'(V_{s_1}) + (\varphi_3 - \varphi_2)'(V_{s_2}) + \cdots\cdots + (\varphi_n - \varphi_{n-1})'(V_{s_n})] + a_1[(\lambda_n - \lambda_1)'(V_{c_1}) + (\lambda_n - \lambda_2)'(V_{c_2}) + \cdots\cdots + (\lambda_n - \lambda_{n-1})'(V_{c_n})]. \quad (11)$$

The corresponding equation for the longitude is

$$0 = +7238.24(\lambda_n - \lambda_{n'})'' + [(\lambda_2 - \lambda_1)'(V_{s_1}) + (\lambda_3 - \lambda_2)'(V_{s_2}) + \cdots\cdots + (\lambda_n - \lambda_{n-1})'(V_{s_n})] + a_2[(\varphi_n - \varphi_1)'(V_{c_1}) + (\varphi_n - \varphi_2)'(V_{c_2}) + \cdots\cdots + (\varphi_n - \varphi_{n-1})'(V_{c_n})]. \quad (12)$$

DISCREPANCY IN GEOGRAPHIC POSITION.

The geodetic position of the U. S. Lake Survey station Penn as computed through the traverse from station Tripp of the transcontinental triangulation, was too small by 0.″155 (4.78 meters) of latitude and too large by 0.″083 (1.92 meters) of longitude when compared with the fixed position of station Penn, the whole discrepancy being 5.15 meters. If the positions of the two fixed stations mentioned above are assumed to be without error, then the whole of the discrepancy is in the traverse and amounts to 1 part in 67 000 of the total length of the traverse. If, on the other hand, the discrepancy is considered to be the closing error of the loop formed by the traverse, the transcontinental triangulation and the U. S. Lake Survey triangulation, then it amounts to 1 part in 380 000 of the length of the whole loop.

THE CONDITION EQUATIONS.

In the actual operation of making the least-squares adjustment the angles at the stations, beginning at North Vernon, were designated by odd numbers and the distances between the stations by even numbers. At the stations where azimuths were determined, the meridian was held as fixed by the astronomic observations, and the angle between the meridian and a line of the traverse was allowed to take a correction in the same manner as an angle between traverse stations. At the azimuth stations and at other stations where there were two angles, the angles were designated by placing a letter after the number, as for example (97a) and (97b).

The first 14 of the following equations represent the azimuth conditions. Equation 15 is an angle condition in a triangle at South Bend where the connection is made to the Lake Survey triangulation. Equations 16 and 17 are, respectively, the latitude and longitude conditions.

No.

1. 0=+18.8+(1)+(3)+(5)+(7)+(9)+(11)+(13)+(15)+(17)+(19)+(21)+(23)+(25a)+(25b).
2. 0=−19.9−(25b)+(27)+(29)+(31)+(33)+(35)+(37)+(39)+(41)+(43)+(45a)+(45b).
3. 0=−30.1−(45b)+(47)+(49)+(51)+(53)+(55)+(57)+(59)+(61)+(63)+(65)+(67)+(69)+(71a)+(71b).
4. 0=+3.4−(71b)+(73)+(75)+(77)+(79)+(81)+(83)+(85)+(87)+(89)+(91)+(93)+(95)+(97a).
5. 0=−18.6+(97b)+(99)+(101)+(103)+(105)+(107)+(109)+(111)+(113a)+(113b).
6. 0=+39.4−(113b)+(115)+(117)+(119)+(121)+(123)+(125)+(127)+(129)+(131a).
7. 0=+8.5+(131b)+(133)+(135)+(137)+(139)+(141)+(145)+(147)+(149)+(151)+(153a)+(153b).
8. 0=+19.4−(153b)+(155)+(157)+(159)+(161)+(163)+(165)+(169)+(171)+(173)+(175)+(177a)+(177b)
9. 0=−11.5−(177b)+(179)+(181)+(183)+(185)+(187)+(189)+(191)+(193)+(195)+(197)+(199)+(201)+(203)+(205)+(207)+(209)+(211a).
10. 0=−33.3+(211b)+(213)+(215)+(217)+(219)+(221)+(223)+(225)+(227)+(229)+(231)+(233)+(235a)+(235b).
11. 0=−11.0−(235b)+(237)+(239)+(241)+(243)+(245)+(217)+(249)+(251)+(253)+(255)+(257)+(259)+(261a)+261b).
12. 0=−44.6−(261b)+(263)+(265)+(267)+(269)+(271)+(273)+(275)+(277)+(279)+(281a).
13. 0=−9.9+(281b)+(283)+(285)+(287)+(289)+(291)+(293)+(295)+(297)+(299)+(301)+(303).
14. 0=−46.0+(303b)+(305)+(307)+(309)+(311)+(313)+(315)+(317)+(319)+(321)+(323)+(325)+(327a)+(327b)+(329a).
15. 0=−0.5+(327b)+(329a)+(329b)+(331).
16. 0=+409.6844+5.34(1)+0.04(2)+5.35(3)+5.53(5)+0.04(6)+5.45(7)+0.12(8)+5.23(9)+0.03(10)
+5.18(11)+0.11(12)+4.91(13)+0.04(14)+4.82(15)+0.34(16)+3.96(17)+0.26(18)+3.32(19)
+0.05(20)+3.19(21)+0.20(22)+2.70(23)+0.02(24)+2.70(25a)+0.08(26)+2.60(27)+0.48(28)
+2.42(29)+0.27(30)+2.32(31)+0.07(32)+2.29(33)+0.14(34)+2.18(35)+0.11(36)+2.09(37)
+0.25(38)+1.86(39)+0.08(40)+1.79(41)+0.02(42)+1.75(43)+0.10(44)+1.52(45a)+0.02(46)
+1.48(47)+0.11(48)+1.42(49)+0.26(50)+1.26(51)+0.15(52)+1.17(53)+0.23(54)+1.02(55)
+0.10(56)+0.96(57)+0.14(58)+0.88(59)+0.20(60)+0.75(61)+0.17(62)+0.65(63)+0.06(64)
+0.65(65)+0.03(66)+0.65(67)+0.84(69)+1.00(71a)+0.10(72)+1.00(73)+0.07(74)+1.00(75)
+1.04(77)+1.18(79)+0.04(80)+1.18(81)+0.14(82)+1.18(83)+0.18(84)+1.18(85)+0.07(86)
+1.17(87)+0.95(89)+0.81(91)+0.08(92)+0.81(93)+0.03(94)+0.81(95)+0.03(96)+0.84(97a)
+0.84(97b)+0.09(98)+1.01(99)+0.05(100)+1.13(101)+0.11(102)+1.40(103)+0.22(104)
+1.64(105)+0.20(106)+1.84(107)+0.05(108)+1.89(109)+0.15(110)+1.89(111)+0.04(112)
+1.88(113a)+0.09(114)+1.88(115)+0.02(116)+1.87(117)+0.02(118)+1.84(119)+0.02(120)
+1.82(121)+0.16(122)+1.76(123)+0.12(124)+1.76(125)+0.07(126)+1.77(127)+0.04(128)
+1.78(129)+0.21(130)+1.82(131a)+1.82(131b)+0.05(132)+1.84(133)+0.02(134)+1.83(135)
+0.04(136)+1.79(137)+0.09(138)+1.77(139)+0.17(140)+1.74(141)+0.36(142)+1.69(143)
+0.14(144)+1.66(145)+0.02(146)+1.65(147)+0.04(148)+1.61(149)+0.12(150)+1.51(151)
+0.16(152)+1.39(153a)+0.10(154)+1.30(155)+0.11(156)+1.22(157)+0.12(158)+1.13(159)
+0.12(160)+1.03(161)+0.15(162)+0.94(163)+0.16(164)+0.84(165)+0.11(166)+0.72(167)
+0.02(168)+0.71(169)+0.07(170)+0.71(171)+0.03(172)+0.72(173)+0.07(174)+0.65(175)
+0.30(176)+0.33(177a)+0.46(178)−0.16(179)+0.08(180)−0.24(181)+0.24(182)−0.49(183)
+0.18(184)−0.68(185)+0.06(186)−0.79(187)+0.01(188)−0.86(189)+0.03(190)−1.21(191)
+0.01(192)−1.27(193)+0.02(194)−1.34(195)+0.04(196)−1.37(197)+0.02(198)−1.42(199)
+0.01(200)−1.48(201)−1.51(203)+0.03(204)−1.52(205)+0.01(206)−1.54(207)+0.01(208)
−1.54(209)−1.47(211a)−1.47(211b)+0.02(212)−1.43(213)+0.01(214)−1.42(215)+0.02(216)
−1.42(217)+0.12(218)−1.37(219)+0.02(220)−1.38(221)+0.03(222)−1.40(223)+0.03(224)
−1.44(225)+0.12(226)−1.60(227)+0.19(228)−1.85(229)+0.03(230)−1.86(231)+0.12(232)
−1.86(233)+0.05(234)−1.86(235a)+0.13(236)−1.80(237)+0.11(238)−1.86(239)+0.23(240)
−1.87(241)+0.20(242)−1.87(243)+0.08(244)−1.91(245)+0.07(246)−1.91(247)+0.11(248)
−1.96(249)+0.04(250)−1.96(251)+0.19(252)−1.96(253)+0.15(254)−1.96(255)+0.10(256)
−2.01(257)+0.10(258)−1.97(259)+0.22(260)−1.97(261a)+0.11(262)−1.98(263)+0.07(264)
−2.01(265)+0.08(266)−2.00(267)+0.02(268)−1.94(269)+0.10(270)−1.77(271)+0.02(272)
−1.74(273)+0.09(274)−1.66(275)+0.26(276)−1.44(277)+0.03(278)−1.42(279)+0.15(280)
−1.18(281a)−1.18(281b)+0.01(282)−1.15(283)+0.04(284)−1.02(285)+0.01(286)−1.01(287)
+0.07(288)−1.01(289)+0.12(290)−1.02(291)+0.17(292)−0.96(293)+0.10(294)−0.92(295)
+0.20(296)−0.85(297)+0.32(298)−0.74(299)+0.04(300)−0.70(301)+0.04(302)−0.71(303a)
−0.71(303b)+0.10(304)−0.66(305)+0.22(306)−0.66(307)+0.19(308)−0.66(309)+0.05(310)
−0.64(311)+0.16(312)−0.45(313)+0.02(314)−0.43(315)+0.02(316)−0.42(317)+0.06(318)
−0.43(319)−0.26(321)+0.02(322)−0.26(323)−0.02(324)−0.19(325)−0.12(327a)+0.15(329a)
+0.15(329b)+0.06(331).
17. 0=+71.4414−4.47(1)−4.45(3)−0.01(4)−4.45(5)−4.44(7)+0.01(8)−4.41(9)−4.40(11)+0.02(12)
−4.37(13)+0.01(14)−4.36(15)+0.05(16)−4.26(17)+0.04(18)−4.19(19)+0.01(20)−4.17(21)
+0.03(22)−4.12(23)−4.11(25a)+0.01(26)−4.09(27)+0.01(28)−3.95(29)+0.01(30)−3.88(31)
−3.86(33)+0.01(34)−3.82(35)+0.01(36)−3.79(37)+0.01(38)−3.72(39)−3.69(41)−3.69(43)
+0.02(44)−3.66(45a)−3.65(47)−3.62(49)+0.01(50)−3.55(51)+0.01(52)−3.51(53)+0.01(54)
−3.44(55)−3.41(57)+0.01(58)−3.38(59)+0.01(60)−3.32(61)+0.01(62)−3.27(63)−3.25(65)
−3.25(67)−0.01(68)−3.25(69)−0.01(70)−3.25(71a)−3.22(73)−3.20(75)−3.20(77)−0.01(78)
−3.20(79)−3.18(81)−3.14(83)−3.09(85)−3.07(87)+0.01(88)−3.07(89)+0.01(90)−3.07(91)
−3.05(93)−3.04(95)−3.03(97a)−3.03(97b)−0.01(98)−3.01(99)−0.01(100)−2.99(101)
−0.02(102)−2.96(103)−0.02(104)−2.90(105)−0.01(106)−2.84(107)−2.83(109)−2.79(111)
−2.78(113a)−2.75(115)−2.75(117)−2.74(119)−2.73(121)−2.69(123)−2.66(125)−2.64(127)
−2.63(129)−2.57(131a)−2.57(131b)−2.55(133)−2.55(135)−2.54(137)−2.51(139)−2.46(141)
−2.36(143)−2.32(145)−2.31(147)−2.30(149)+0.01(150)−2.27(151)+0.01(152)−2.22(153a)
+0.01(154)−2.19(155)+0.01(156)−2.16(157)+0.01(158)−2.13(159)+0.01(160)−2.09(161)
+0.01(162)−2.05(163)+0.01(164)−2.01(165)+0.01(166)−1.98(167)−1.97(169)−1.95(171)
−1.94(173)−1.92(175)+0.02(176)−1.84(177a)+0.03(178)−1.71(179)+0.01(180)−1.68(181)
+0.02(182)−1.62(183)+0.01(184)−1.57(185)+0.01(186)−1.55(187)−1.55(189)+0.02(190)
−1.54(191)−1.54(193)−1.53(195)−1.52(197)−1.51(199)−1.51(201)−1.51(203)−1.50(205)
−1.50(207)−1.50(209)−1.50(211a)−1.50(211b)−1.49(213)−1.49(215)−1.48(217)−1.45(219)
−1.45(221)−1.44(223)−1.43(225)+0.01(226)−1.40(227)+0.02(228)−1.34(229)−1.34(231)
−1.30(233)−1.29(235a)−1.25(237)−1.22(239)−1.15(241)−1.10(243)−1.07(245)−1.06(247)
−1.02(249)−1.01(251)−0.96(253)−0.92(255)−0.89(257)−0.86(259)−0.80(261a)−0.77(263)
−0.75(265)−0.72(267)−0.72(269)−0.01(270)−0.69(271)−0.69(273)−0.66(275)−0.01(276)
−0.59(277)−0.58(279)−0.02(280)−0.54(281a)−0.54(281b)−0.53(283)−0.01(284)−0.52(285)
−0.52(287)−0.50(289)−0.46(291)−0.42(293)−0.39(295)−0.33(297)−0.01(298)−0.24(299)
−0.23(301)−0.22(303a)−0.22(303b)−0.19(305)−0.13(307)−0.07(309)−0.06(311)−0.01(312)
−0.01(313)−0.01(315)+0.02(319)−0.01(320)+0.02(321)+0.02(323)+0.02(325)+0.02(327a)
−0.01(329a)−0.01(329b)−0.02(331).

TABLES OF CORRECTIONS.

In the following tables are given the corrections to the angles and distances as derived from the least-squares adjustment. In the first table are given the name of the station at which the angle was observed, the designation given to the angle in the adjustment, and the correction to the angle in seconds. The mean correction to the angles necessary to satisfy all conditions as imposed was slightly less than 2″.

In the second table are given the names of the two stations at the ends of each line whose length was measured, the designation assigned to this length in the adjustment, the correction to the seventh place of the logarithm of this length, and in the last column, the proportional part of the correction to the whole length of the line. An examination of this table shows that only 16 of the 163 distances were changed by as much as 1 part in 100 000. The maximum change was 1 part in 46 000 which occurred on the distance between Clark and Clinton. The mean change of all the lengths amounts to 19 in the seventh place of the logarithm or to 1 part in 228 000.

Table of corrections to horizontal angles.

Station.	Designation of angle used in the adjustment.	Correction.	Station.	Designation of angle used in the adjustment.	Correction.
Tripp	(1)	− 3.7	Prospect	(75)	− 0.2
Adams	(3)	− 3.7	Michigan	(77)	− 0.3
North Vernon	(5)	− 4.1	Emerson	(79)	− 0.6
Allen	(7)	− 3.9	Subway	(81)	− 0.5
Bartholomew	(9)	− 3.4	Thoaman	(83)	− 0.4
Benton	(11)	− 3.3	Pendleton	(85)	− 0.3
Blackfork	(13)	− 2.7	Avenue	(87)	− 0.2
Boon	(15)	− 2.5	Brightwood	(89)	+ 0.2
Brown	(17)	− 0.5	Keystone	(91)	+ 0.5
Corroll	(19)	+ 0.9	Lake	(93)	+ 0.5
Cass	(21)	+ 1.2	Erie	(95)	+ 0.5
Columbus	(23)	+ 2.3	Western	(97a)	+ 0.5
Clay	(25a)	+ 2.3	Western	(97b)	+ 2.5
Clay	(25b)	+ 2.3	Gibson	(99)	+ 2.2
Clark	(27)	+ 0.3	Grant	(101)	+ 2.0
Clinton	(29)	+ 1.0	Green	(103)	+ 1.6
Edinburg	(31)	+ 1.3	Castleton	(105)	+ 1.2
Crawford	(33)	+ 1.4	Fisher	(107)	+ 1.0
Daviess	(35)	+ 1.7	Frazier	(109)	+ 0.9
Dearborn	(37)	+ 2.0	Hamilton	(111)	+ 1.0
Decature	(39)	+ 2.6	Hancock	(113a)	+ 1.0
Decalb	(41)	+ 2.8	Hancock	(113b)	+ 5.2
Delaware	(43)	+ 2.9	Harrison	(115)	− 4.1
Dubois	(45a)	+ 3.4	Stake	(117)	− 4.1
Dubois	(45b)	+ 2.8	Stub	(119)	− 4.0
Franklin	(47)	+ 0.7	Fill	(121)	− 3.9
Elkhart	(49)	+ 0.9	Hendricks	(123)	− 3.7
Whiteland	(51)	+ 1.4	Brays	(125)	− 3.6
Fayette	(53)	+ 1.7	Fox	(127)	− 3.6
Floyd	(55)	+ 2.1	Prairie	(129)	− 3.6
Greenwood	(57)	+ 2.3	Henry	(131a)	− 3.6
Fountain	(59)	+ 2.6	Henry	(131b)	− 1.6
Fulton	(61)	+ 2.9	Cicero	(133)	− 1.6
Traction	(63)	+ 3.3	Tucker	(135)	− 1.6
Shelby	(65)	+ 3.3	Howard	(137)	− 1.5
Troy	(67)	+ 3.3	Kinders	(139)	− 1.3
Kerk	(69)	+ 2.9	Arcada	(141)	− 1.2
Sherman	(71a)	+ 2.6	Cox	(143)	− 0.8
Sherman	(71b)	+ 2.9	Jay	(145)	− 0.7
Elevator	(73)	− 0.2	Jasper	(147)	− 0.6

Table of corrections to horizontal angles—Continued.

Station.	Designation of angle used in the adjustment.	Correction.	Station.	Designation of angle used in the adjustment.	Correction.
Tipton	(149)	− 0.5	Grass	(241)	+0.9
Ressler	(151)	− 0.3	Newton	(243)	+1.0
Jackson	(153a)	+ 0.1	Noble	(245)	+1.1
Jackson	(153b)	+ 3.1	Kewanna	(247)	+1.1
New Hope	(155)	− 2.9	Ohio	(249)	+1.3
Midway	(157)	− 2.6	Orange	(251)	+1.3
Sharp	(159)	− 2.4	Owen	(253)	+1.5
Jefferson	(161)	− 2.1	Park	(255)	+1.6
Duncan	(163)	−1.8	Perry	(257)	+1.7
Jennings	(165)	−1.5	Delong	(259)	+1.7
Main	(167)	−1.2	Porter	(261a)	+1.8
Buckeye	(169)	−1.2	Porter	(261b)	−2.6
Kokomo	(171)	−1.1	Posey	(263)	+4.5
Penn	(173)	−1.1	Putnam	(265)	+4.6
Lacy	(175)	−0.9	Culver	(267)	+4.7
Cassedy	(177a)	−0.1	Randolph	(269)	+4.6
Cassedy	(177b)	+2.6	Riple	(271)	+4.3
Shope	(179)	−1.4	Rush	(273)	+4.2
Bennett	(181)	−1.2	Hibbard	(275)	+4.1
Laporte	(183)	−0.6	Spencer	(277)	+3.8
Anoka	(185)	−0.1	Twin	(279)	+3.8
Junction	(187)	+0.2	Joseph	(281a)	+3.4
Laurra	(189)	+0.3	Joseph	(281b)	+1.0
Frate	(191)	+1.0	Starke	(283)	+1.0
Yarde	(193)	+1.2	Stuben	(285)	+0.7
Wabash	(195)	+1.3	Plymouth	(287)	+0.7
River	(197)	+1.4	Sullivan	(289)	+0.8
Lagrange	(199)	+1.5	Switzerland	(291)	+0.9
Mulborn	(201)	+1.7	Harris	(293)	+0.9
Logansport	(203)	+1.7	Tippecanoe	(295)	+0.8
Eel	(205)	+1.8	Lapaz	(297)	+0.8
Miami	(207)	+1.8	Union	(299)	+0.8
Vandalia	(209)	+1.8	Mourhess	(301)	+0.7
Leonda	(211a)	+1.7	Aman	(303a)	+0.8
Leonda	(211b)	+2.0	Aman	(303b)	+3.4
Knox	(213)	+1.9	States	(305)	+3.4
Horney	(215)	+1.9	Hilberry	(307)	+3.5
Laurence	(217)	+1.9	Peacock	(309)	+3.7
Lawn	(219)	+1.9	Wehr	(311)	+3.7
Martha	(221)	+1.9	Lloyd	(313)	+3.4
Madison	(223)	+2.0	Studebaker	(315)	+3.4
Marion	(225)	+2.1	Griffith	(317)	+3.3
Marchal	(227)	+2.5	Indiana	(319)	+3.4
Martin	(229)	+3.1	South Bend	(321)	+3.1
Monroe	(231)	+3.1	Bud	(323)	+3.1
Lucerne	(233)	+3.2	Lincoln	(325)	+2.9
Boon	(235a)	+3.2	South Bend west base	(327a)	+2.8
Boon	(235b)	+2.7	South Bend west base	(327b)	+1.6
Montgomery	(237)	+0.6	Penn (U. S. L. S.)	(329a)	+1.3
Morgan	(239)	+0.7	Penn (U. S. L. S.)	(329b)	−1.3
			South Bend east base	(331)	−1.1

Table of corrections to the measured lengths.

Stations at ends of line.	Designation of length in adjustment.	Correction to length in seventh place of logarithm.	Ratio of correction to total length as 1 to—
Tripp-Adams	(2)	− 8	543 000
Adams-North Vernon	(4)	− 2	2 171 000
North Vernon-Allen	(6)	− 8	543 000
Allen-Bartholomew	(8)	−22	197 000
Bartholomew-Benton	(10)	− 6	724 000
Benton-Blackfork	(12)	−18	241 000
Blackfork-Boon	(14)	− 6	724 000
Boon-Brown	(16)	−57	76 000
Brown-Corroll	(18)	−43	101 000
Corroll-Cass	(20)	− 8	543 000
Cass-Columbus	(22)	−33	132 000
Columbus-Clay	(24)	− 4	1 086 000
Clay-Clark	(26)	−14	310 000
Clark-Clinton	(28)	−94	46 000
Clinton-Edinburg	(30)	−52	84 000
Edinburg-Crawford	(32)	−14	310 000
Crawford-Daviess	(34)	−26	167 000
Daviess-Dearborn	(36)	−20	217 000
Dearborn-Decature	(38)	−48	90 000
Decature-Decalb	(40)	−16	271 000
Decalb-Delaware	(42)	− 4	1 086 000
Delaware-Dubois	(44)	−15	290 000
Dubois-Franklin	(46)	− 4	1 086 000
Franklin-Elkhart	(48)	−22	197 000
Elkhart-Whiteland	(50)	−50	87 000
Whiteland-Fayette	(52)	−28	155 000
Fayette-Floyd	(54)	−44	99 000
Floyd-Greenwood	(56)	−20	217 000
Greenwood-Fountain	(58)	−26	167 000
Fountain-Fulton	(60)	−38	114 000
Fulton-Traction	(62)	−32	136 000
Traction-Shelby	(64)	−12	362 000
Shelby-Troy	(66)	− 6	724 000
Troy-Kerk	(68)	− 2	2 171 000
Kerk-Sherman	(70)	− 2	2 171 000
Sherman-Elevator	(72)	−20	217 000
Elevator-Prospect	(74)	−14	310 000
Prospect-Michigan	(76)	0	.....
Michigan-Emerson	(78)	− 2	2 171 000
Emerson-Subway	(80)	− 8	543 000
Subway-Thoaman	(82)	−28	155 000
Thoaman-Pendleton	(84)	−36	121 000
Pendleton-Avenue	(86)	−14	310 000
Avenue-Brightwood	(88)	+ 2	2 171 000
Brightwood-Keystone	(90)	+ 2	2 171 000
Keystone-Lake	(92)	−16	271 000
Lake-Erie	(94)	− 6	724 000
Erie-Western	(96)	− 6	724 000
Western-Gibson	(98)	−20	217 000
Gibson-Grant	(100)	−12	362 000
Grant-Green	(102)	−26	167 000
Green-Castleton	(104)	−48	90 000
Castleton-Fisher	(106)	−42	103 000
Fisher-Frazier	(108)	−10	434 000
Frazier-Hamilton	(110)	−30	145 000
Hamilton-Hancock	(112)	− 8	543 000
Hancock-Harrison	(114)	−18	241 000
Harrison-Stake	(116)	− 4	1 086 000
Stake-Stub	(118)	− 4	1 086 000
Stub-Fill	(120)	− 4	1 086 000
Fill-Hendricks	(122)	−32	136 000
Hendricks-Brays	(124)	−24	181 000
Brays-Fox	(126)	−14	310 000
Fox-Prairie	(128)	− 8	543 000
Prairie-Henry	(130)	−42	103 000

Table of corrections to the measured lengths—Continued.

Stations at ends of line.	Designation of length in adjustment.	Correction to length in seventh place of logarithm.	Ratio of correction to total length as 1 to—
Henry-Cicero	(132)	−10	434 000
Cicero-Tucker	(134)	− 4	1 086 000
Tucker-Howard	(136)	− 8	543 000
Howard-Kinders	(138)	−18	241 000
Kinders-Arcada	(140)	−34	128 000
Arcada-Cox	(142)	−72	60 000
Cox-Jay	(144)	−28	155 000
Jay-Jasper	(146)	− 8	543 000
Jasper-Tipton	(148)	− 8	543 000
Tipton-Ressler	(150)	−22	197 000
Ressler-Jackson	(152)	−30	145 000
Jackson-New Hope	(154)	−18	241 000
New Hope-Midway	(156)	−20	217 000
Midway-Sharp	(158)	−22	197 000
Sharp-Jefferson	(160)	−22	197 000
Jefferson-Duncan	(162)	−28	155 000
Duncan-Jennings	(164)	−30	145 000
Jennings-Main	(166)	−20	217 000
Main-Buckeye	(168)	− 4	1 086 000
Buckeye-Kokomo	(170)	−14	310 000
Kokomo-Penn	(172)	− 6	724 000
Penn-Lacy	(174)	−14	310 000
Lacey-Cassedy	(176)	−56	78 000
Cassedy-Shope	(178)	−85	51 000
Shope-Bennett	(180)	−14	310 000
Bennett-Laporte	(182)	−44	99 000
Laporte-Anoka	(184)	−34	128 000
Anoka-Junction	(186)	−10	434 000
Junction-Laurra	(188)	− 2	2 171 000
Laurra-Frate	(190)	− 2	2 171 000
Frate-Yarde	(192)	− 2	2 171 000
Yarde-Wabash	(194)	− 4	1 086 000
Wabash-River	(196)	− 8	543 000
River-Lagrange	(198)	− 4	1 086 000
Lagrange-Mulborn	(200)	− 2	2 171 000
Mulborn-Logansport	(202)	0	.....
Logansport-Eel	(204)	− 6	724 000
Eel-Miami	(206)	− 2	2 171 000
Miami-Vandalia	(208)	− 2	2 171 000
Vandalia-Leonda	(210)	0	.....
Leonda-Knox	(212)	− 4	1 086 000
Knox-Horney	(214)	− 2	2 171 000
Horney-Laurence	(216)	− 4	1 086 000
Laurence-Lawn	(218)	−24	181 000
Lawn-Martha	(220)	− 4	1 086 000
Martha-Madison	(222)	− 6	724 000
Madison-Marion	(224)	− 6	724 000
Marion-Marchal	(226)	−22	197 000
Marchal-Martin	(228)	−34	128 000
Martin-Monroe	(230)	− 6	724 000
Monroe-Lucerne	(232)	−24	181 000
Lucerne-Boon	(234)	−10	434 000
Boon-Montgomery	(236)	−26	167 000
Montgomery-Morgan	(238)	−22	197 000
Morgan-Grass	(240)	−46	94 000
Grass-Newton	(242)	−40	109 000
Newton-Noble	(244)	−16	271 000
Noble-Kewanna	(246)	−14	310 000
Kewanna-Ohio	(248)	−22	197 000
Ohio-Orange	(250)	− 8	543 000
Orange-Owen	(252)	−38	114 000
Owen-Park	(254)	−30	145 000
Park-Perry	(256)	−20	217 000
Perry-Delong	(258)	−20	217 000
Delong-Porter	(260)	−44	99 000

Table of corrections to the measured lengths—Continued.

Stations at ends of line.	Designation of length in adjustment.	Correction to length in seventh place of logarithm.	Ratio of correction to total length as 1 to—
Porter-Posey	(262)	−22	197 000
Posey-Putnam	(264)	−14	310 000
Putnam-Culver	(266)	−16	271 000
Culver-Randolf	(268)	− 4	1 086 000
Randolf-Riple	(270)	−22	197 000
Riple-Rush	(272)	− 4	1 086 000
Rush-Hibbard	(274)	−18	241 000
Hibbard-Spencer	(276)	−54	80 000
Spencer-Twin	(278)	− 6	724 000
Twin-Joseph	(280)	−34	128 000
Joseph-Starke	(282)	− 2	2 171 000
Starke-Stuben	(284)	−10	434 000
Stuben-Plymouth	(286)	− 2	2 171 000
Plymouth-Sullivan	(288)	−14	310 000
Sullivan-Switzerland	(290)	−24	181 000
Switzerland-Harris	(292)	−34	128 000
Harris-Tippecanoe	(294)	−20	217 000
Tippecanoe-Lapaz	(296)	−40	109 000
Lapaz-Union	(298)	−66	66 000
Union-Mourhess	(300)	− 8	543 000
Mourhess-Aman	(302)	− 8	543 000
Aman-States	(304)	−20	217 000
States-Hilberry	(306)	−44	99 000
Hilberry-Peacock	(308)	−38	114 000
Peacock-Wehr	(310)	−10	434 000
Wehr-Lloyd	(312)	−34	128 000
Lloyd-Studebaker	(314)	− 4	1 086 000
Studebaker-Griffith	(316)	− 4	1 086 000
Griffith-Indiana	(318)	−12	362 000
Indiana-South Bend	(320)	− 2	2 171 000
South Bend-Bud	(322)	− 4	1 086 000
Bud-Lincoln	(324)	+ 4	1 086 000
Lincoln-South Bend west base	(326)	0	.....
South Bend west base-South Bend east base	.....	.....	.....

DEFLECTIONS IN THE PRIME VERTICAL AND IN THE MERIDIAN.

The following tables show the deflections in the prime vertical and in the meridian at three stations of the transcontinental triangulation in Indiana. They are included here simply that all essential data for this State may be kept together in one report.

Deflections in the prime vertical.

Name of station.	Geodetic latitude.	Geodetic longitude.	Astronomic longitude.	A–G.	Cos ϕ.[1]	A–G (P. V.)
	° ′ ″	° ′ ″	″	″		″
O. and M., 1914	38 29 00.278	85 40 11.497	11.69	+0.19	0.7828	+0.15
Louisville, 1880	38 15 06.791	85 45 31.823	30.85	−0.97	0.7855	−0.76
Vincennes, 1881	38 40 35.70	87 31 35.05	30.14	− 4.91	0.7807	−3.83

[1] ϕ is the geodetic latitude.

Deflections in the meridian.

Name of station.	Geodetic latitude.	Geodetic longitude.	Astronomic latitude.	A–G.
	° ′ ″	° ′ ″	″	″
O. and M., 1914	38 29 00.278	85 40 11.497	01.93	+1.65
Louisville, 1880	38 15 06.791	85 45 31.823	08.01	+1.22
Vincennes, 1881	38 40 35.70	87 31 35.05	36.80	+1.10

INDEX TO POSITIONS, DESCRIPTIONS, ELEVATIONS, AND SKETCHES.

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Fulton	14	40	.....	19
Galena (U. S. L. S.)	21	56	26	23
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Gibson	14	42	.....	19
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Jasper	15	45	.....	20
Jay	15	44	.....	20
Jefferson	16	45	.....	20
Jeffersonville, Government tower	12	.....	.....	17
Jefferson (U. S. L. S.)	21	55	26	24
Jennings	16	46	.....	20
Joseph	18	52	.....	22
Junction	16	47	.....	21
Kerk	14	40	.....	19
Kewanna	17	50	.....	21
Kewanna Baptist Church	20	.....	.....	21
Keystone	14	41	.....	19
Kinders	15	44	.....	20
Knox	17	48	.....	21
Kokomo	16	46	.....	20
Lacy	16	46	.....	20
Lagrange	16	47	.....	21
Lake	14	41	.....	19
Lapaz	18	52	.....	22
Laporte	16	47	.....	21
Latitude and longitude, Vincennes	11	33	.....	16
Laurence	17	48	.....	21
Laurra	16	47	.....	21
Lawn	17	48	.....	21
Leonard	10	31	.....	16
Leonda	17	48	.....	21
Lincoln	19	54	.....	22
Lloyd	19	53	.....	22
Logansport	16	48	.....	21
Louisville north base	12	35	26	17
Louisville south base	12	35	26	17
Lucerne	17	49	.....	21
Lutz	11	34	26	17
Madison	17	48	.....	21
Main	16	46	.....	20
Marchal	17	49	.....	21
Marion	17	49	.....	21
Martha	17	48	.....	21
Martin	17	49	.....	21
Marysville	11	34	26	17
Merom College	11	32	.....	16
M. E. Church, New Carlisle (U. S. L. S.)	22	.....	.....	23
Miami	17	48	.....	21
Michigan	14	40	.....	19
Michigan City, 1877 (U. S. L. S.)	22	56	.....	23
Michigan City, 1908 (U. S. L. S.)	23	57	.....	23
Michigan City high school (U. S. L. S.)	22	.....	.....	.....
Midway	16	45	.....	20
Miller	10	31	26	16, 17
Millers (U. S. L. S.)	22	57	26	23
Milton (U. S. L. S.)	21	56	26	22, 23, 24
Mongo (U. S. L. S.)	21	55	26	24
Monroe	17	49	.....	21
Montgomery	17	49	.....	21
Morgan	17	49	.....	21
Mourhess	18	53	.....	22
Mud Lick	10	30	.....	17
Mulborn	16	47	.....	21
New Albany: Second Presbyterian Church	12	.....	.....	17
New Albany: Waterworks tower	12	.....	.....	17
New Carlisle: Christian Church (U. S. L. S.)	22	.....	.....	23
New Carlisle: M. E. Church (U. S. L. S.)	22	.....	.....	23
New Hope	16	45	.....	20
Newton	17	49	.....	21
Noble	17	50	.....	21
North Vernon	12	36	.....	18
Notre Dame University, South Bend (U. S. L. S.)	22	.....	.....	23
O. & M	11	34	26	17
Ohio	17	50	.....	21
Orange	17	50	.....	21
Osborn	10	32	.....	16
Otis (U. S. L. S.)	22	56	.....	23
Owen	17	50	.....	21
Park	18	50	.....	21
Peacock	19	53	.....	22
Pendleton	14	41	.....	19
Penn	16	46	.....	20
Penn (U. S. L. S.)	21	56	26	22, 23, 24
Perry	18	50	.....	21
Plymouth	18	52	.....	22
Plymouth: Courthouse	20	.....	.....	22
Plymouth: Schoolhouse	20	.....	.....	22
Popp	11	34	26	17
Porter	18	50	.....	21
Porter (U. S. L. S.)	21	55	26	24
Posey	18	51	.....	21
Potts	12	36	.....	17
Prairie	15	44	.....	20
Presbyterian Church, Second, New Albany	12	.....	.....	17
Prospect	14	40	.....	19
Putnam	18	51	.....	21
Queenville: Schoolhouse, cupola	19	.....	.....	18
Queenville: Schoolhouse, flagpole	19	.....	.....	18
Quincy (U. S. L. S.)	20	55	26	24
Randolf	18	51	.....	21
Rariden	10	31	26	16
Reading (U. S. L. S.)	20	54	26	24
Reizin	10	29	.....	17

Station.	Position.	Description.	Elevation.	Sketch.
	Page.	*Page.*	*Page.*	*No.*
Ressler	15	45	.....	20
Riley	12	35	26	17
Riple	18	51	.....	21
River	16	47	.....	21
Rush	18	51	.....	21
Sabinsky (U. S. L. S.)	24	57	.....	23
St. John's Church (U. S. L. S.)	23	58	.....	23
St. Paul's Church (U. S. L. S.)	24	58	.....	23
Schoolhouse, Plymouth	20	.....	.....	22
Sharp	16	45	.....	20
Shelby	14	40	.....	19
Sherman	14	40	.....	19
Sherman (U. S. L. S.)	21	55	26	24
Shope	16	46	.....	20
Shot Tower (U. S. L. S.)	22	57	.....	23
Sims	12	35	.....	17
Sisson	11	32	.....	16
Six Mile	11	34	26	17
South Bend	19	54	.....	22
South Bend east base	19	54	.....	22
South Bend: Notre Dame University (U. S. L. S.)	22	.....	.....	23
Standpipe (U. S. L. S.)	22	.....	.....	23
South Bend west base	19	54	.....	22
Spencer	18	51	.....	22
Springville (U. S. L. S.)	22	56	.....	23
Stake	15	43	.....	19
Standpipe, South Bend (U. S. L. S.)	22	.....	.....	23
Starke	18	52	.....	22
States	19	53	.....	22
Stockton (U. S. L. S.)	24	53	.....	23
Stout	10	30	26	17
Stow	10	29	.....	17
Stub	15	43	.....	19
Stuben	18	52	.....	22
Studebaker	19	53	.....	22
Sub	15	43	.....	19
Subway	14	41	.....	19
Sullivan	18	52	.....	22
Summit 1884	11	32	.....	16
Summit 1886	11	34	26	17
Switzerland	18	52	.....	22
Tanner	10	29	.....	17
Thoaman	14	41	.....	19
Tippecanoe	18	52	.....	22
Tipton	15	45	.....	20
Tipton Catholic Church	20	.....	.....	20
T. 36 N., R. 4 W., NW. Cor. Sec. 10 (U. S. L. S.)	23	.....	.....	.....
T. 36 N., R. 7 W., SE. Cor. NE. ¼ sec. 6 (U. S. L. S.)	23	.....	.....	.....
T. 37 N., R. 1 W., Cor. Secs. 2, 3, 10, and 11 (U. S. L. S.)	23	.....	.....	.....
T. 37 N., R. 3 W., SE. Cor. Sec. 10 (U. S. L. S.)	23	.....	.....	.....
T. 37 N., R. 3 E., Cor. Secs. 17, 18, 19, and 20 (U. S. L. S.)	22	.....	.....	.....
T. 37 N., R. 6 E., Cor. Secs. 2, 3, 10 and 11 (U. S. L. S.)	22	.....	.....	.....
T. 37 N., R. 11 E., Cor. Secs. 4, 5, 8, and 9 (U. S. L. S.)	22	.....	.....	.....
T. 38 N., R. 2 W., SW. Cor. SE. ¼ of SW. ¼ Sec. 32 (U. S. L. S.)	23	.....	.....	.....
T. 38 N., R. 8 E., NW. ¼ Sec. 33 (U. S. L. S.)	22	.....	.....	.....
T. 38 N., R. 14 E., NW. Cor. Sec. 31 (U. S. L. S.)	22	.....	.....	.....
Traction	14	40	.....	19
Tripp	10	30	26	17, 18
Troy	14	40	.....	19
Tucker	15	44	.....	20
Twin	18	51	.....	22
Union	18	53	.....	22
Van Buren (U. S. L. S.)	21	55	26	24
Vandalia	17	48	.....	21
Vincennes: Courthouse	11	.....	.....	16
Latitude and longitude	11	33	.....	16
Wabash	16	47	.....	21
Watertank: Edinburg Cabinet Co.	19	.....	.....	18
Franklin Manufacturing Co.	20	.....	.....	19
Franklin Masonic Home	20	.....	.....	19
Greenwood Indian Canning Co.	20	.....	.....	19
Waterworks tower, New Albany	12	.....	.....	17
Weed Patch	10	31	.....	16, 17
Wehr	19	53	.....	22
West Pierhead light (U. S. L. S.)	23	58	.....	23
Western	14	42	.....	19
Whiteland	13	39	.....	19
Whiteland: M. E. Church, steeple	20	.....	.....	19
Schoolhouse, cupola	20	.....	.....	19
Williams	12	35	26	17
Wolf Hill	11	.....	.....	16
Wolf River (U. S. L. S.)	25	58	.....	23
Wright	11	32	.....	16
Yankee (U. S. L. S.)	24	.....	.....	23
Yarde	16	47	.....	21

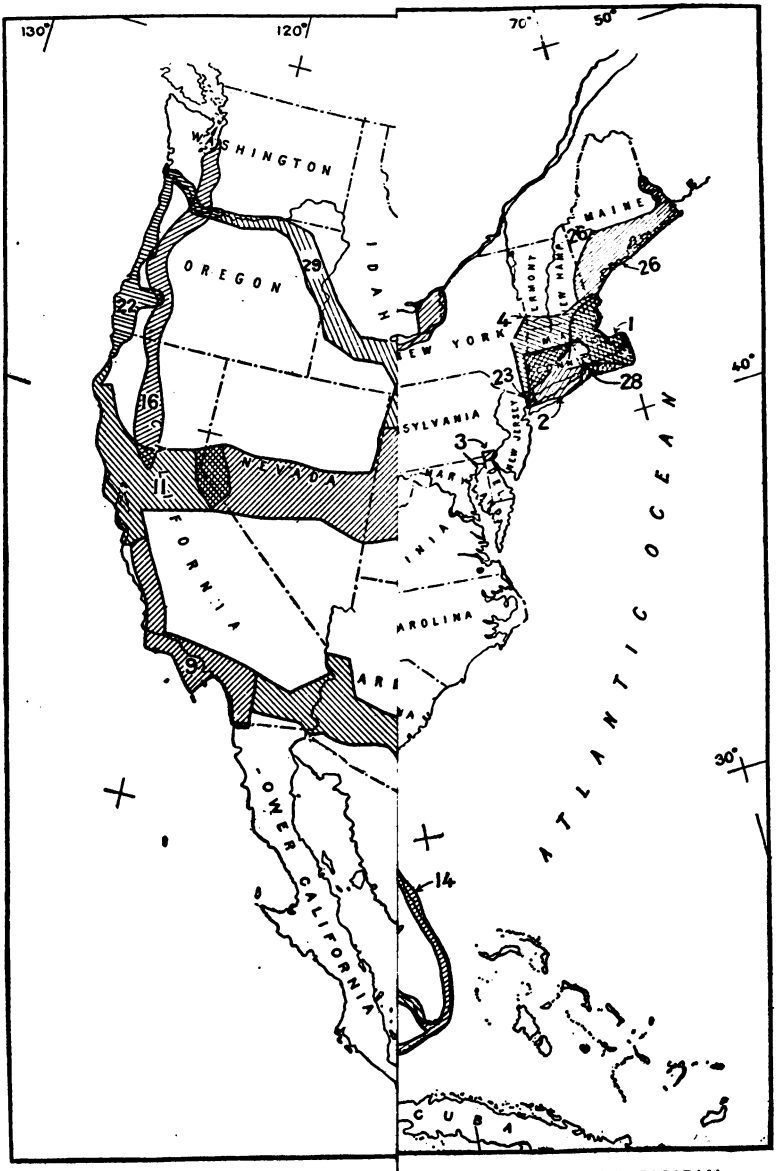

Fig. 14.—INDEX MAP SHOWING WHICH HAVE BEEN RIGIDLY

1. Appendix 8, Report for 1885 (superseded by Special Publication No. 76).
2. Appendix 8, Report for 1888.
3. Appendix 8, Report for 1893.
4. Appendix 10, Report for 1894 (superseded by Special Publication No. 76).

26. Special Publication No. 46.
27. Special Publication No. 54.
28. Special Publication No. 62.
29. Special Publication No. 74.
30. Special Publication No. 78.
31. Special Publication No. 79.
32. Special Publication No. — (in press.)

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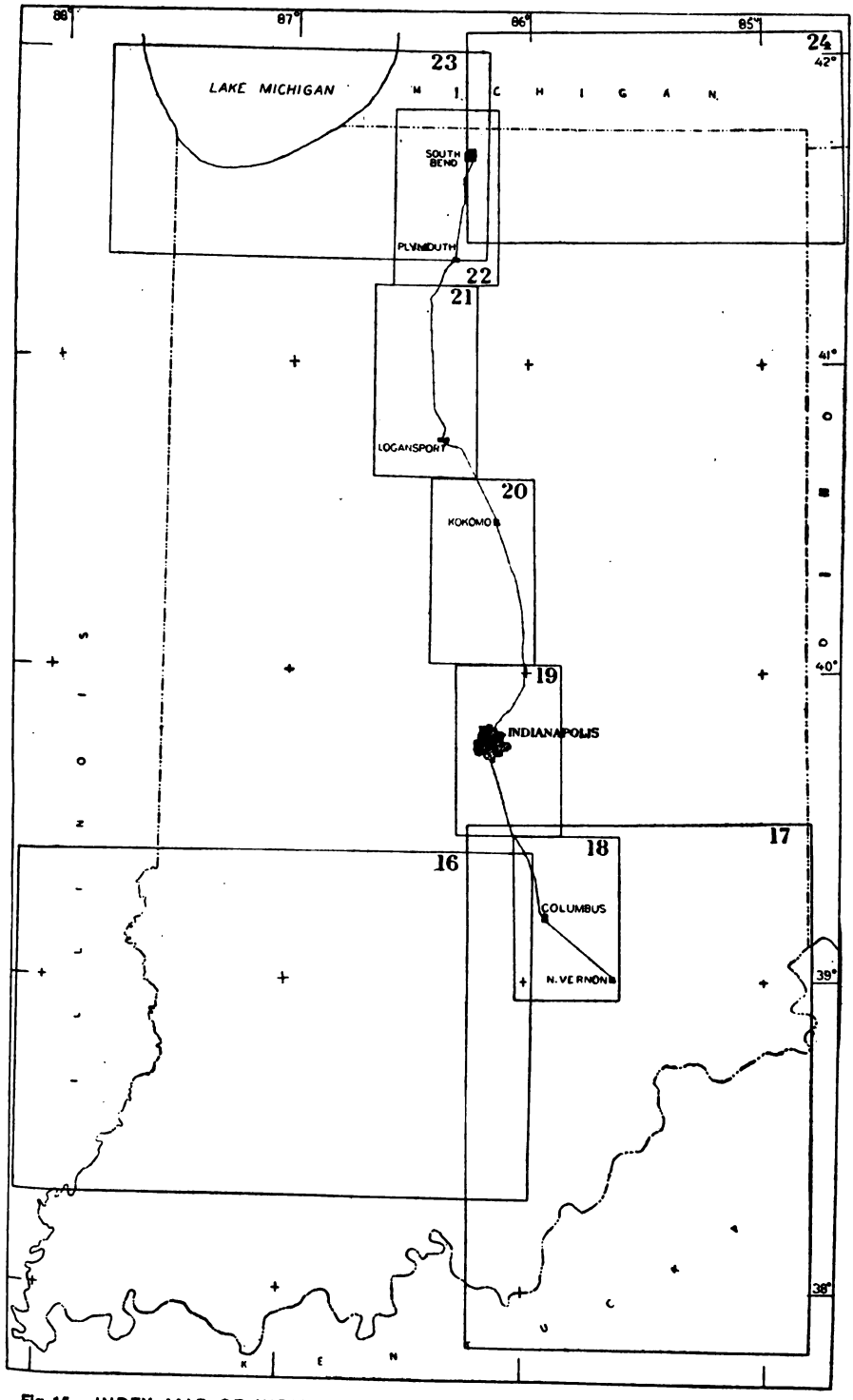
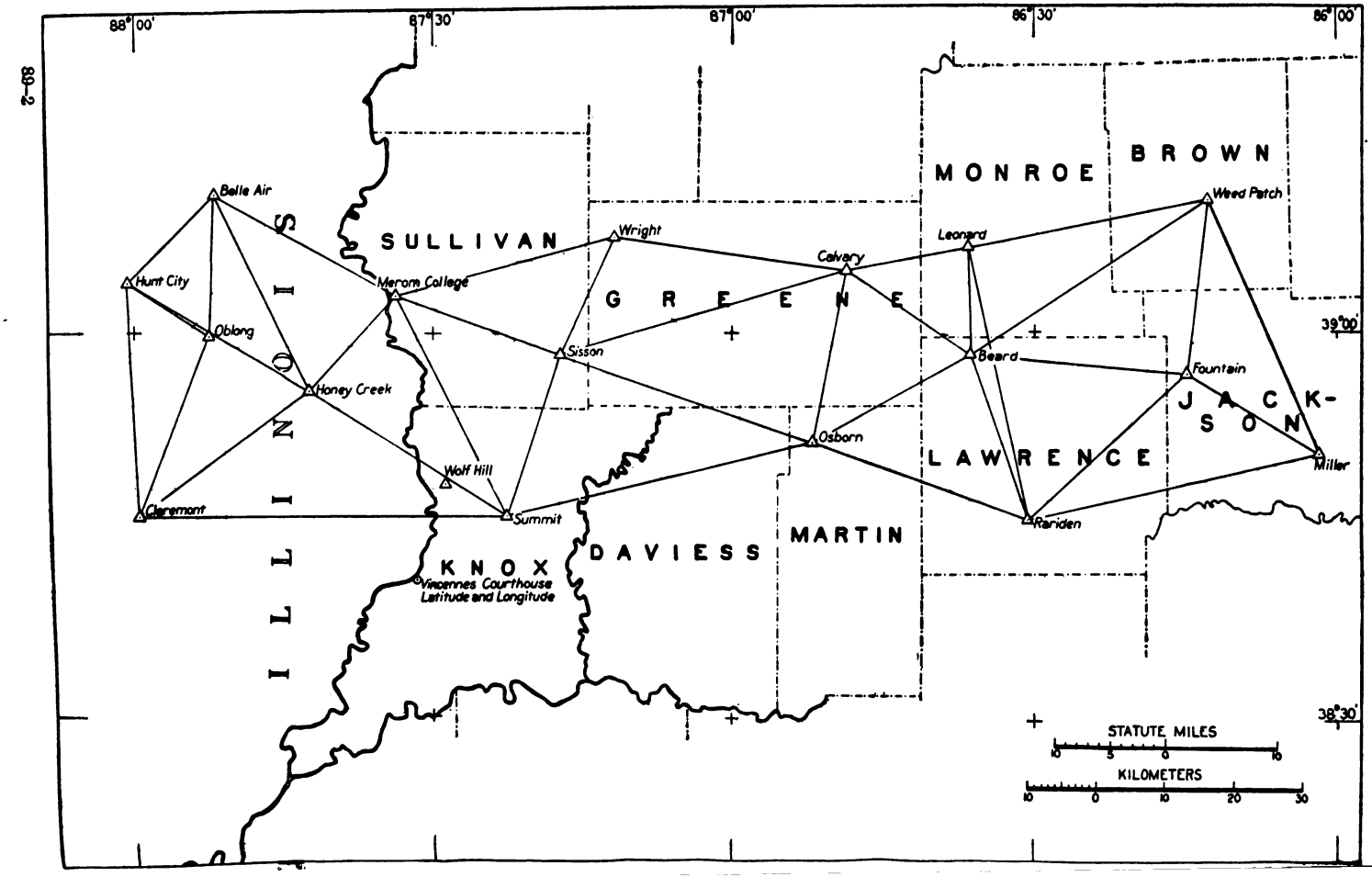


Fig. 15.—INDEX MAP OF INDIANA SHOWING THE BOUNDARIES OF EACH OF THE SKETCHES, FIGURES 16 TO 24.


88° 00'
87° 30'
87° 00'
86° 30'
86° 00'
39° 00'
38° 30'
Belle Air
Hunt City
Oblong
Honey Creek
Claremont
Merom College
Wright
Sisson
Calvary
Wolf Hill
Summit
Osborn
Leonard
Beard
Weed Patch
Fountain
Miller
Rariden
SULLIVAN
GREENE
MONROE
BROWN
JACKSON
LAWRENCE
KNOX
DAVIESS
MARTIN
ILLINOIS
Vincennes Courthouse
Latitude and Longitude
STATUTE MILES
10 5 0 10
KILOMETERS
10 0 10 20 30

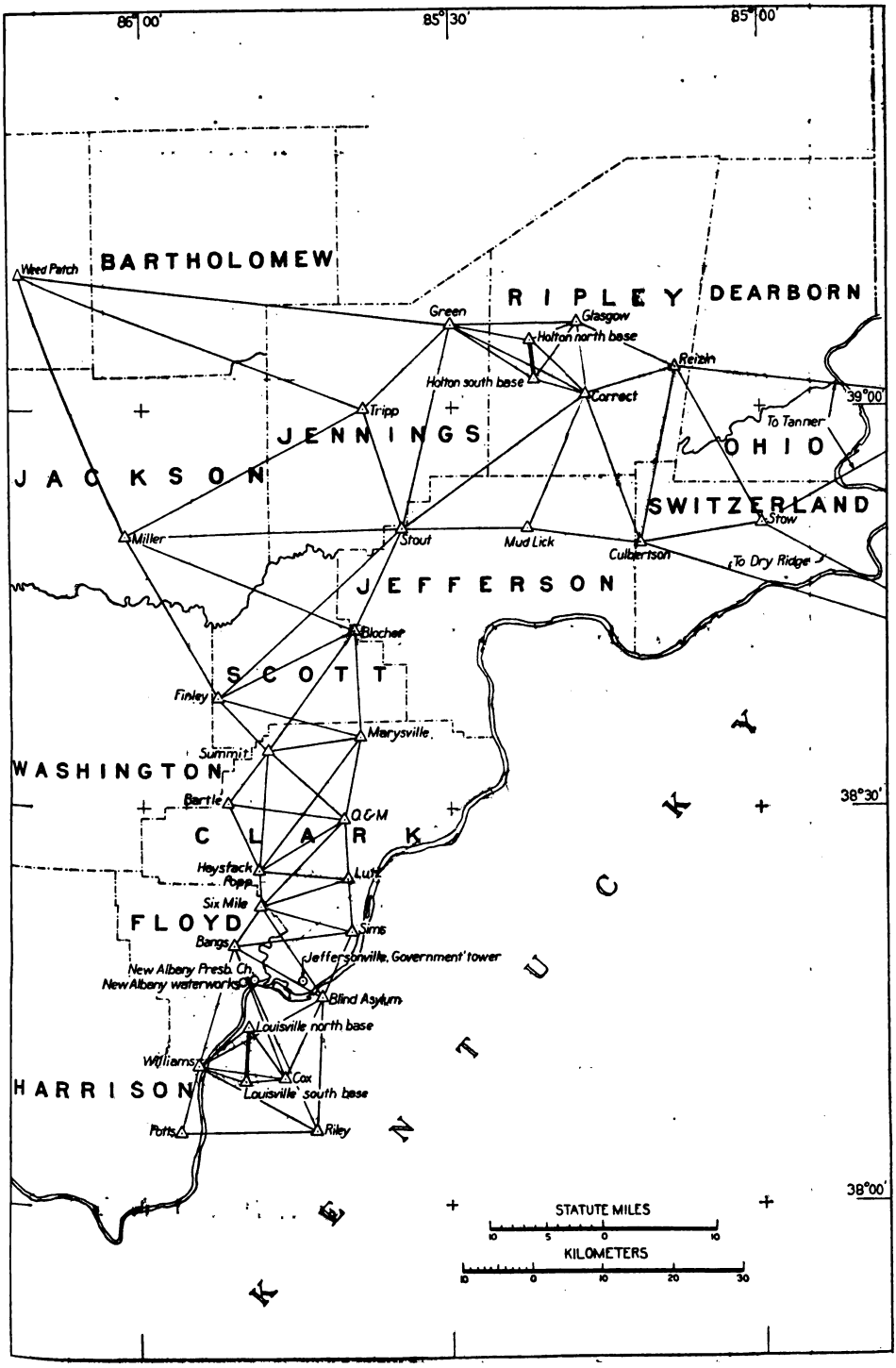


Fig. 17.—TRIANGULATION ALONG THE THIRTY-NINTH PARALLEL AND SOUTH TO LOUISVILLE, KY.

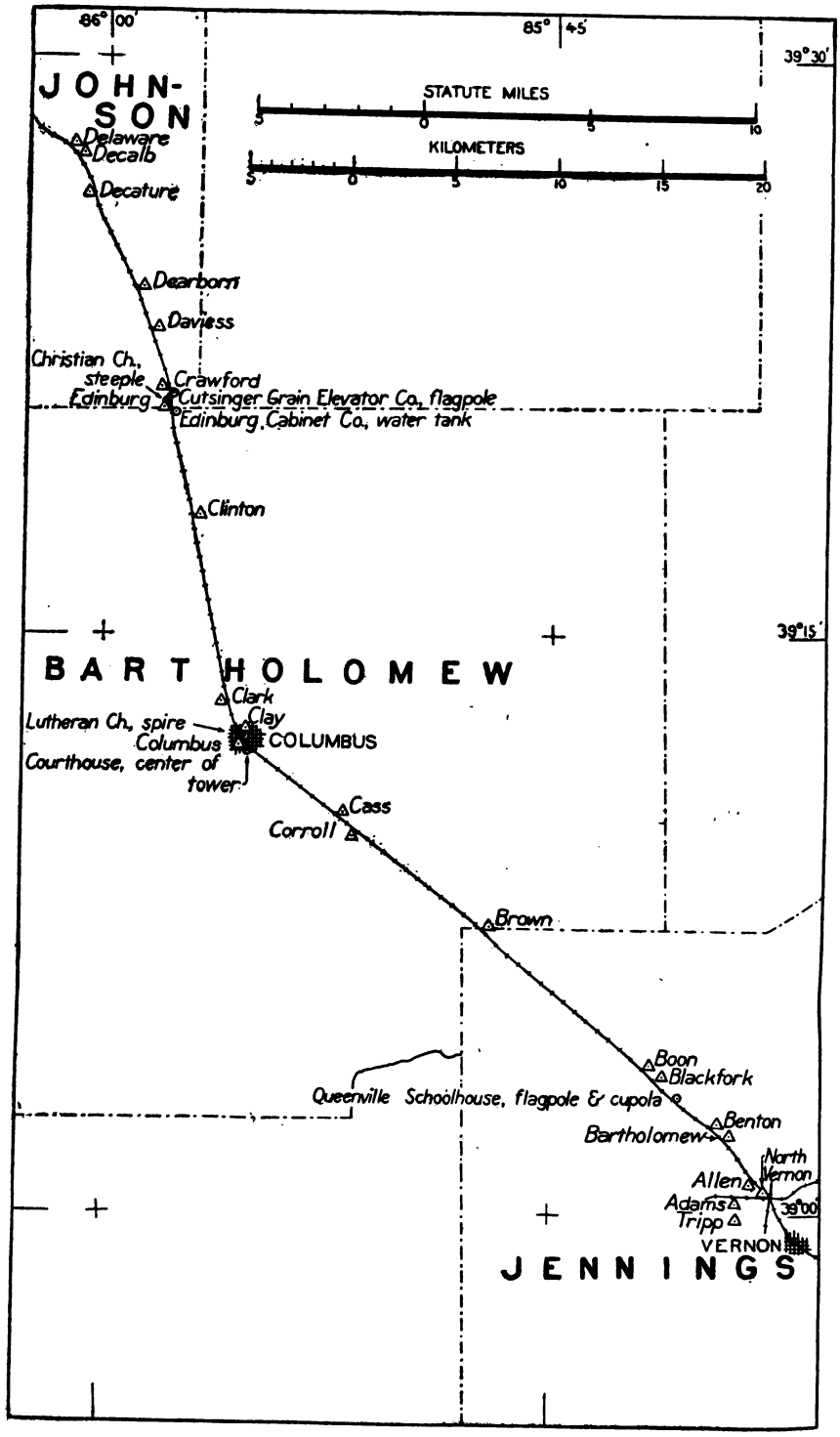


Fig. 18.—PRECISE TRAVERSE, NORTH VERNON TO FRANKLIN.

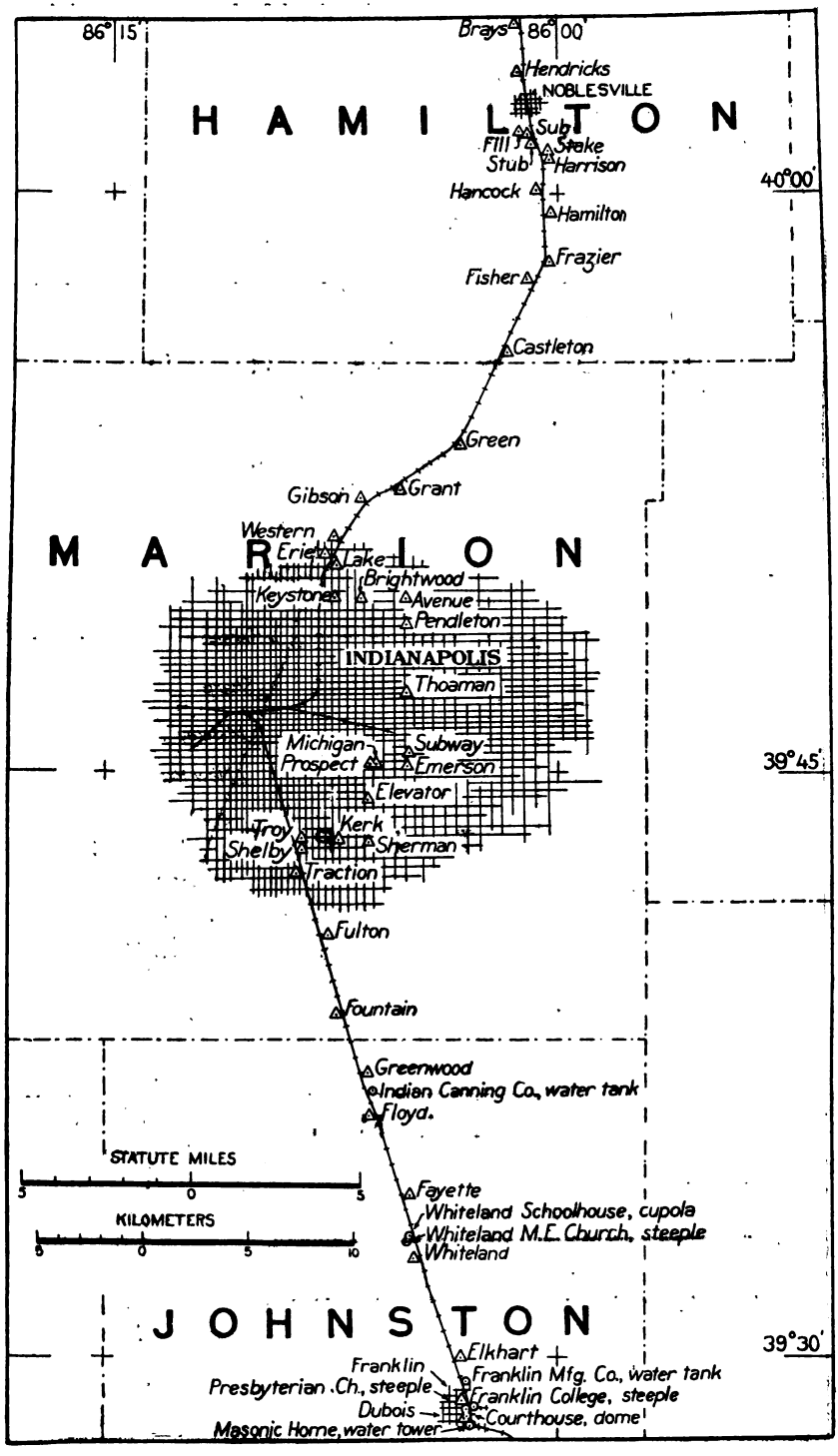


Fig. 19.—PRECISE TRAVERSE, FRANKLIN TO NOBLESVILLE.

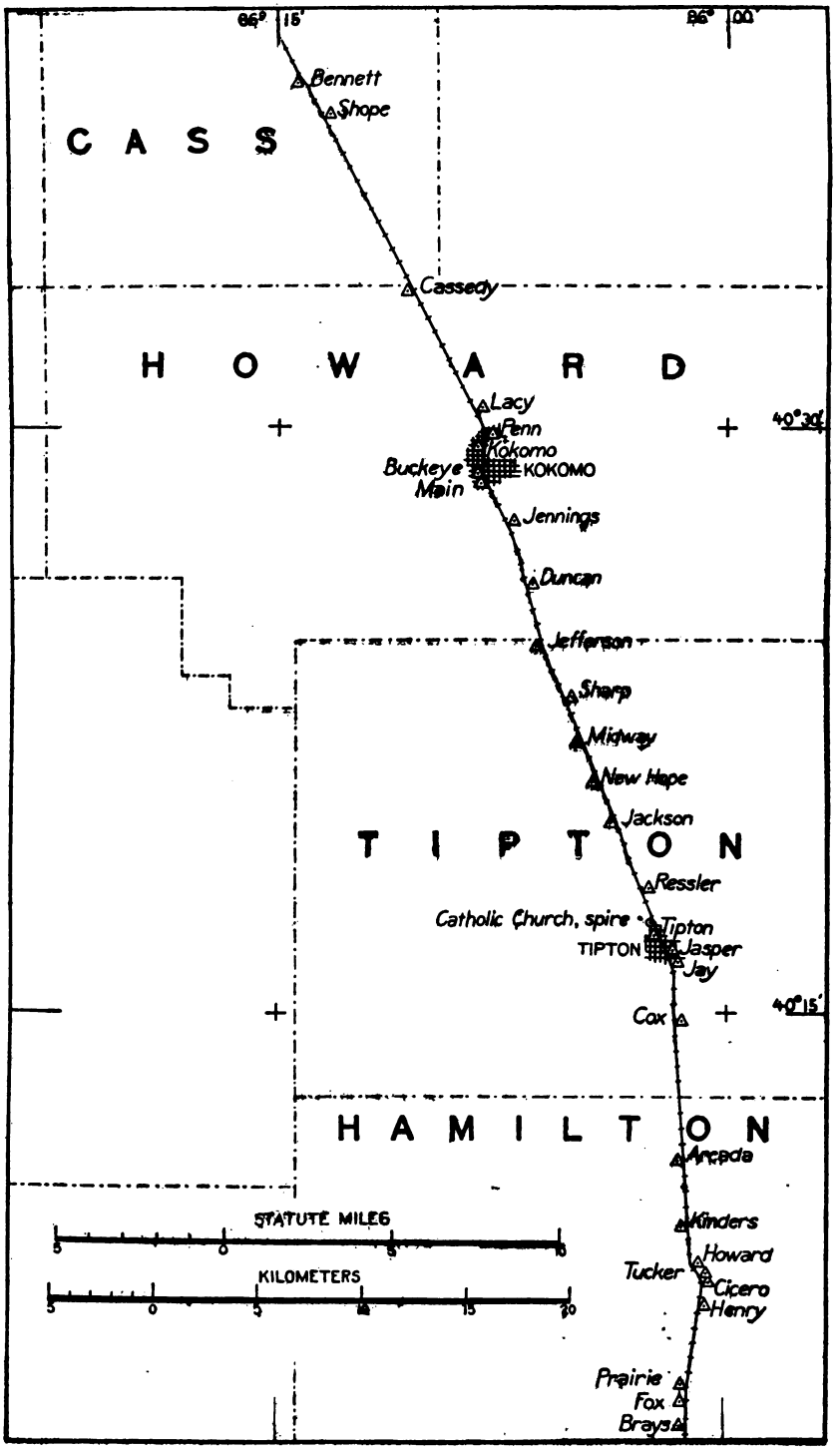


Fig. 20.—PRECISE TRAVERSE, NOBLESVILLE THROUGH KOKOMO.

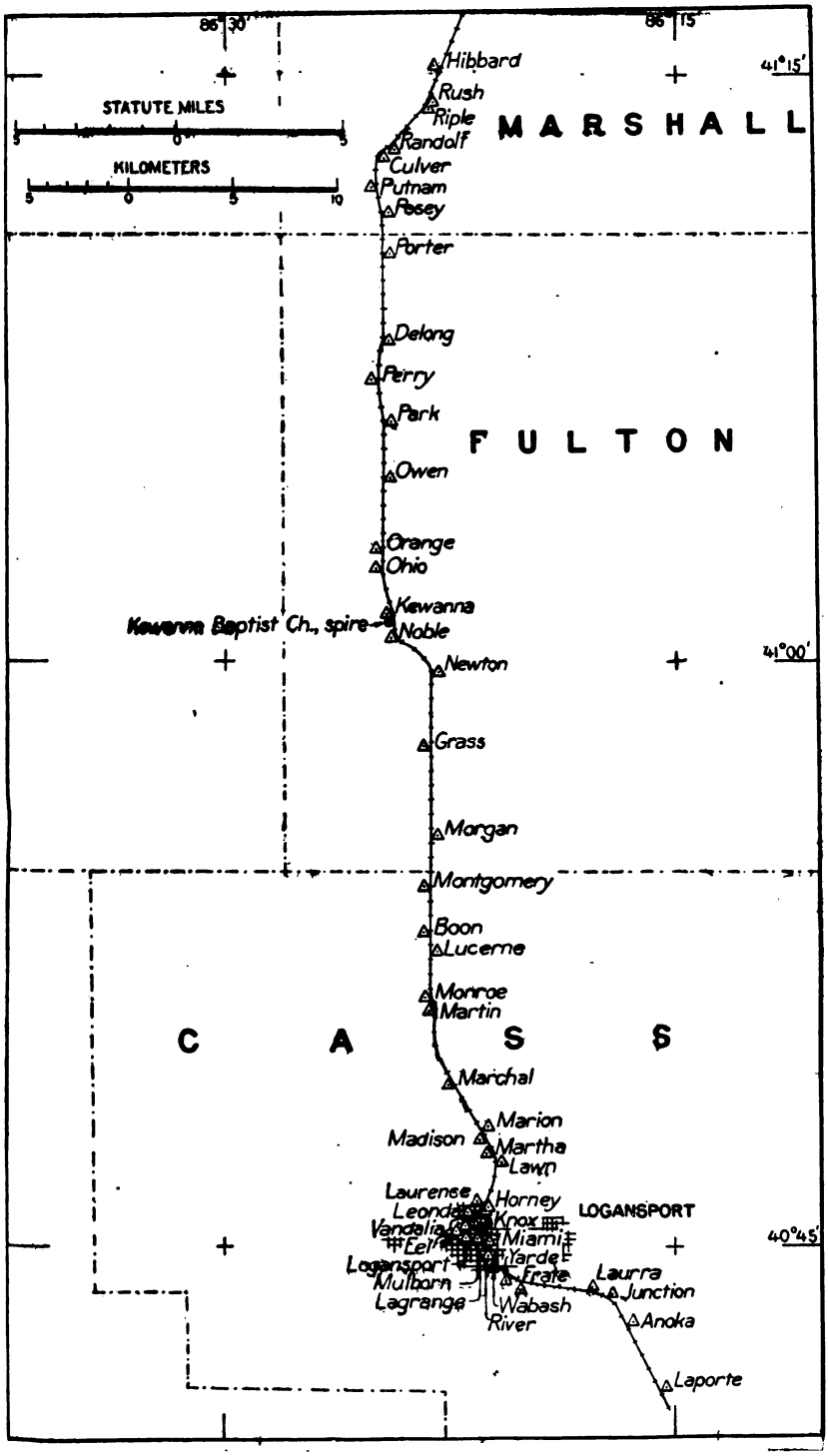


Fig. 21.—PRECISE TRAVERSE, SOUTH OF LOGANSPORT TO CULVER.

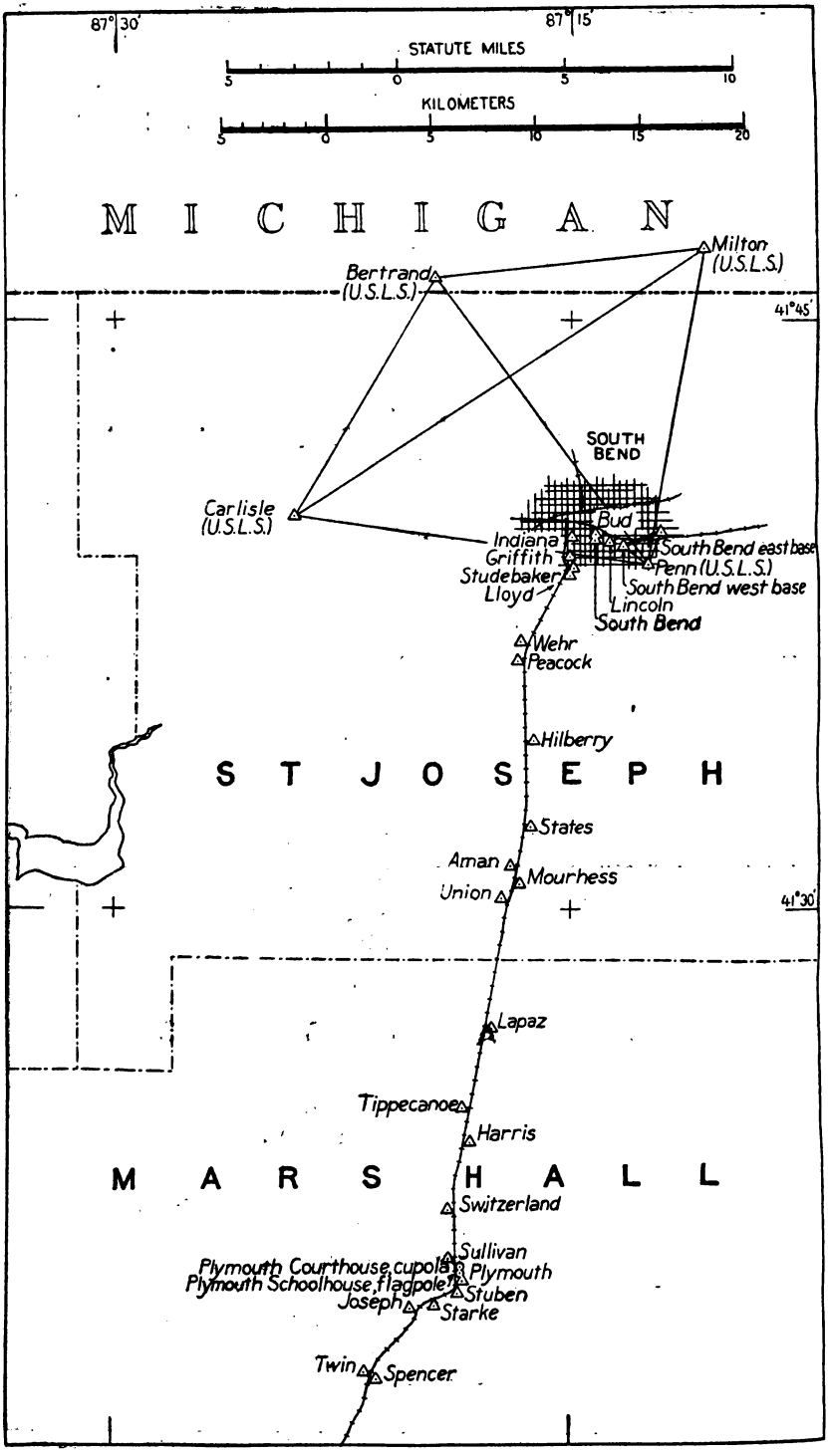


Fig. 22.—PRECISE TRAVERSE, CULVER TO SOUTH BEND.